RAILWAY ENGINEERING
AND MAINTENANCE OF WAY.

BRIDGES—BUILDINGS—CONTRACTING—SIGNALING—TRACK

New Series, Vol. VIII
Old Series, Vol. XXVII | Chicago | JANUARY, 1912 | New York | No. 1

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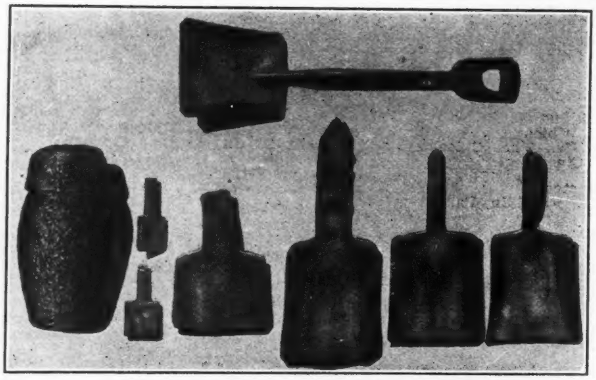

The above cut shows the process of making Hussey-Binns Shovels. The entire metal portion is made of one piece without welds or rivets, giving maximum strength and durability.

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"Hussey-Binns" Shovels when making your requisition, and you will obtain 50 to 100 per cent greater wear, and better service:

¶ Greater wear because the metal part is made in ***one piece*** from a single ingot of ***solid crucible cast steel.***

¶ Better service because the ***steel*** shovel blade will hold its edge and produce more work.

HUSSEY-BINNS SHOVEL CO., PITTSBURGH, PA., U. S. A.

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Construction WRENCHES

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RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

WITH WHICH IS INCORPORATED
ROADMASTER AND FOREMAN

BRIDGES—BUILDINGS—CONTRACTING—SIGNALING—TRACK

Published by THE RAILWAY LIST COMPANY

WILLIAM E. MAGRAW, Pres. and Treas.
CHAS. S. MYERS, Vice-Pres.
C. C. ZIMMERMAN, Bus. Mgr.
J. M. CROWE, Mgr. Central Dist.
LYNDON F. WILSON, Managing Editor
KENNETH L. VAN AUKEN, B.S.C.E., Assoc. Ed.
OWEN W. MIDDLETON, B.S.M.E., Assoc. Ed.

Office of Publication: Manhattan Building, Chicago
Telephone, Harrison 4948
Eastern Office: 50 Church Street, New York
Telephone, Cortlandt 5765
Central Office: 403 House Bldg., Pittsburg

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, signaling, bridges and buildings.
Communications on any topic suitable to our columns are solicited.
Subscription price, $1.00 a year; to foreign countries, $1.50, free of postage. Single copies, 10 cents. Advertising rates given on application to the office, by mail or in person.
In remitting, make all checks payable to the Railway List Company.
Papers should reach subscribers by the twentieth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be very gladly sent.
This Publication has the largest paid circulation of any railway journal in the Maintenance of Way field.

Entered as Second-Class Matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

New Series, Vol. 8
Old Series, Vol. 27 Chicago, January, 1912 No. 1

CONTENTS.

Foreign Work for the Railway Civil Engineer.

THE DEVELOPMENT of railways in South America within recent years has been great, but it probably cannot compare in magnitude with that in prospect for the next few years. Many engineers now employed on the railways of the United States have seen service in some Latin-American country, usually Mexico, and nearly all of the engineers in charge of work in Latin-American countries have seen service on United States railways. In fact, in construction, if not in maintenance as well, the American or British engineer is the mainstay of the Latin-American railway magnate.

Of South American countries, Argentina is furthest advanced in railway mileage, with Brazil a close second. The interest of the engineer who delights in difficult problems is, however, attracted by the construction work in Chile. This country had the first steam railway of any of the Latin-American countries. It was opened for traffic in 1851. In spite of this fact Chile is far behind the others in development. Topographical obstacles are responsible for this state of affairs. These, however, are being rapidly surmounted by engineering talent and home financing. Within a few years Chile was joined to Bolivia by a railway starting from the port of Antofagasta and running 1,055 miles to the Bolivian capital, over the highest mountains of any system in the world. As above stated, this road was built by Chilean capital, but has passed into the hands of an English company.

The beginning of an important policy, which is the union of Chile with the countries on the other side of the Andes, gives them the benefit of Pacific ports with comparatively short hauls. There are now in existence concessions for the construction of five trans-Andine railways, one of which is being built by means of English contracts and will soon be completed. These projects call for the most advanced engineering talent, as the nature of the construction is such that the most serious obstacles will have to be surmounted.

Maintenance engineers who have seen Latin-American service are usually prejudiced against its conditions, and with reason. In construction work, however, the conditions in Chile are not far different from those in this country. There real brain work is appreciated perhaps to a greater extent than at home.

Keeping Posted.

THERE IS NOTHING of quite so much importance in the modern business world today as to keep posted. Keen competition of the day demands it and efficiency demands it. To do our work right we must keep ourselves posted.

"To keep posted means more than simply the two words that represent it. There are certain things which we cannot help being posted about—things and events that are brought to our attention as regular detail; but this is rather 'being' posted than 'keeping' posted. Going out of our way to get information is 'keeping' posted, and that is what counts.

"We are efficient only in the measure in which we keep posted. Our duties and our environments prescribe to us about what things we must be best posted, but there is no limit to the things about which we can be posted. The better we are posted the more confidence we have in ourselves. The successful man is the well-posted man."

The above extracted from an article from one of our exchanges expresses the spirit of all men who are interested in their own advancement. Competition would force such a policy even if there were no other reason for it.

The men who wish to keep posted, and therefore the men who are posted, will in most every case be found to be men who are readers of technical literature concerning their own vocation. The discriminate reader will most carefully pick out for subscription that paper which is published solely for and in the interest of his own class, provided there is such a publication.

The advantages are all in favor of such a journal with a field restricted to one department. The advertisers in such a publication will be only those who are anxious to reach the one class catered to. Every page of the paper will then be of interest to each subscriber, for he knows or should know that every page of every issue (including those of the advertising section) are published solely to interest himself and his associates in the same department.

Maintenance of Way Efficiency.

THE GREAT IMPORTANCE of having railway material on the work on time is constantly being given more attention by railway officials. On another page of this issue is an article on efficiency in maintenance of way methods on the Erie R. R. The work on this railway has been thoroughly systematized, and a system of advance and progress reports has been established. From these reports a program is made out which shows with comparative accuracy the time that certain kinds of material will be needed on the different sections of the road. Once this program is made out, it must be adhered to.

A combined report is compiled and kept in the division offices. From this report it is easy to deduce the exact amounts of material of a certain kind required and the date on which that certain material will be needed. A work train distributing table can then be easily made up to take care of the distribution in the most consistent and efficient manner.

The distribution over the entire division could probably be taken care of by one train crew and distributing gang. Both of these units could attain higher speed in the distribution, and what is of even more importance, higher efficiency in the proper distribution of the exact quantities needed. Estimates of the conductor and foreman as to the quantity of material in the cars and the time to unload them will result in so adjusting the number of cars in each train load, that much time in the aggregate may be saved. This would result from the easier and quicker starting and stopping and more accurate spotting of the cars. Or more cars may be hauled accomplishing the same amount of distribution with a lessening of the number of trips to the material yard. An added point of efficiency would probably result from the better co-operation between conductor and foreman, which is much to be desired, as it is a fact that often these employes work at cross purposes.

The Engineers' Distress.

TWO MEMBERS of the younger set in the profession of railway engineering have hit upon a somewhat unique but, nevertheless, an effective method of laying before their superiors some of the discouragements and difficulties of the engineering department employe. In a facetious mood they used their spare hours in getting certain ideas into readable form by means of caricature and satire. Tracing and prints were then made, one of the sets of the latter falling into our hands. We printed two pages of "The Engineers' Distress" in the December issue and the results were such as to warrant their continuation. For those familiar with the atmosphere, there is many a good laugh to be found on these pages. It is our desire and expectation, however, that something of more lasting benefit may be gleaned from the reading of this feature. This is our purpose in continuing its publication. We might add that suggestion and comment from readers will be welcomed.

NEW TUNNEL, B. & O. R. R.

The Baltimore & Ohio is at present constructing a new tunnel parallel to the old Sand Patch tunnel in the Alleghenies. The heavy traffic at this point requires additional tracks. The tunnel is to be double tracked, so that eventually there will be three tracks instead of one as at present.

The new tunnel is to be about 4,000 feet long which is approximately 800 feet shorter than the old one. The approach cut on the west is partially a widening of the old approach cut, the portal being about 300 feet north of the old one. The cut is in solid rock and is being made with a slope of ⅛ to 1. The old slope is ½ to 1. A concrete drain is to be laid at the top of the solid rock to intercept drainage water from the earth slope above. The new cut is being made with four steam shovels, two 70-ton Bucyrus and two Marion shovels. The material is being handled in four yard dump cars with dinky locomotives. The old line is not available for use in construction, as the one track is under heavy scheduled traffic and cannot be obstructed.

Two shafts were sunk and two headings are being driven from each shaft. In one shaft top headings are being used, each 9x16 feet. In the other shaft headings of the same size are being used, but it was deemed advisable to use bottom headings on account of the nature of the strata. The rock encountered so far has been very firm, no timbering being required. Little water has been encountered and a rate of 70 feet in one week has been attained with 13 eight-hour shifts.

CANADIAN CREOSOTING PLANT.

The creosoting plant at the Troon Harbour sleeper mill, Glasgow, is being moved from Glasgow to Canada. Messrs. Bruce, the proprietors, are opening works at Fort Frances, Ontario, in the center of the timber region, and are also starting at Vancouver, B. C. The cylinder of the Troon works—which will be replaced by another later on—weighs 30 tons, and is capable of impregnating 500 ties at a time, or 2,000 per day. It is one of four which are being transported to the other side of the Atlantic.

At their new Canadian works, Messrs. Bruce will introduce the zinc-chloride-aluminum patent immersing process, which is preservative, and—what is of equal importance—fireproof. The firm has just secured an important two years' contract for a Canadian railway, and have obtained the sole rights for Canada of this improved method of treating railway ties.

Wood Preservers' Association.

During the World's Fair at St. Louis in 1904 a few interested parties got together and organized what is now called the Wood Preservers' Association. The meeting was held in Room 4, Transporation Building, on the World's Fair grounds at St. Louis, October 10, 1904. The following were present:

F. J. Angier.
R. L. Armstrong.
J. S. Baker.
F. D. Beal.
C. W. Berry.
O. Chanute.
Jos. K. Choate.
Charles E. Cobean.
P. F. Dundon.
James E. Gatewood.
A. W. Hawkes.
H. J. James.
F. A. Kummer.
John T. Logan.
C. B. Lowry.
A. Nestor.
R. P. Perry.
F. Schiewind.
Amos M. Smith.
Wm. Townsley, Jr.
H. J. Valentine.
C. S. Walker.
J. H. Waterman.
W. J. Whitmore.

The meeting was called to order and Mr. J. S. Baker was elected temporary chairman. Mr. Baker announced the object of the meeting to be the formation of a permanent organization of those interested in the practical work of timber preservation, and suggested the election of a permanent chairman and a committee to prepare a plan of organization. Mr. Octave Chanute was elected permanent chairman and Mr. F. A. Kummer was made secretary. Mr. Chanute then announced the following, a committee on organization: Messrs. J. S. Baker, C. W. Berry, F. D. Beal, A. Nestor, C. B. Lowry.

This committee made their report and recommended that a permanent organization be formed, to be known as the "American Society of Wood Preservers"; that all executive and administrative officers of operating plants would be eligible to membership; the officers to consist of a president, three vice-presidents and a secretary-treasurer. They recommended that meetings be held annually, the meeting place


JOHN T. LOGAN,
Pres. National Lumber & Creosoting Co.
President.


ANDREW GIBSON,
Engr. M. W., Nor. Pac. Ry.
1st Vice President.


D. BURKHALTER,
Supt. Creosoting Plant, B. R. & P. Ry.
3rd Vice President.

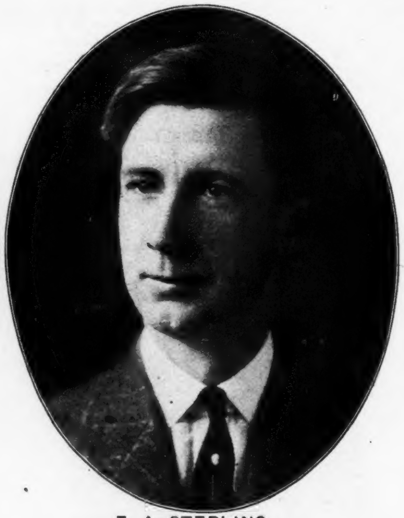

F. J. ANGIER,
Supt. Timb. Pres., B. & O. R. R.
Secretary-Treasurer.


A. E. LARKIN,
Gen'l. Supt., Republic Creosoting Co.
Chairman Program Committee.


W. F. GOLTRA.
Pres. & G. M., W. F. Goltra Tie Co.
Member Program Committee.

GEORGE E. REX,
Mgr. Treat. Plants, A. T. & S. F. Ry.
Member Program Committee.

J. H. WATERMAN,
Supt. Timb. Pres., C. B. & Q. R. R.
Member Program Committee.



E. A. STERLING,
Forester, Pennsylvania R. R.
Member Program Committee.

for the following year to be selected at each meeting. During the discussion of the committee's report a motion was made and carried that the name of the association be changed to the Wood Preservers' Association. At the close of this meeting an election of officers was held, the following being elected:

President—Mr. J. S. Baker.

First Vice-President—Mr. C. B. Lowry.

Second Vice-President—Mr. W. J. Whitmore.

Third Vice-President—Mr. F. A. Kummer.

Secretary-Treasurer—Mr. C. W. Berry.

The first annual meeting of the association was held at the St. Charles Hotel, New Orleans, La., on January 17, 18

WALTER BUEHLER,
Pres., Kettle River Co.
Member Advertising Committee.

and 19, 1905. At this meeting the constitution and by-laws were adopted, and are the same as we are now working under. However, a Committee on the Revision of the Constitution and By-Laws will make its report at the next meeting in January, 1912.

The second annual meeting was held at the Palmer House, Chicago, Ill., January 16, 17 and 18, 1906, and Mr. C. B. Lowry, president, presided.

The third annual meeting was held in Memphis, Tenn., January 15, 16 and 17, 1907, Mr. C. B. Lowry, president, in the chair.

The fourth annual meeting was held at Kansas City, Mo., January 21, 22 and 23, 1908, Mr. C. B. Lowry, president, wielding the gavel.

The fifth annual meeting was held at Chicago, Ill., on January 19, 1909, Mr. Walter Buehler, president, in the chair.

The sixth annual meeting was held at Chicago, Ill., January 18, 19 and 20, Mr. Walter Buehler, presiding.

The seventh annual meeting was held at Chicago, Ill., on January 17, 18 and 19, 1911, President Walter Buehler presiding.

The annual meeting January 16, 17 and 18 is the eighth, Mr. John T. Logan being president.

The program of the Association, January 16, 17 and 18, at Hotel Sherman, Chicago, contains papers for discussion as follows: The Production of the Wooden Cross Tie, A. R. Royce; Treating Seasoned vs. Unseasoned Ties, F. J. Angier; Inspection of Materials and Treatments at Commercial Plants, R. L. Allardyce; Creosote and Creosoting Oils, David Allerton; Cutting and Seasoning Timber, August Meyer; Preservation of Power Transmission Poles, W. R. Wheaton; Efficiency in Plant Operation, E. A. Sterling; Wood Block Pavement From Construction Standpoint, Day I. Okes; Creosote Oil—Specifications and Methods of Analysis, S. R. Church; The Scientific Management of Timber Preserving Plants, D. Burkhalter; Economic Materials for Boat and Barge Construction, A. E. Hageboeck; Evaporation of Creosote and Crude Oils, P. E. Fredenoll. The program includes, in addition, an illustrated lecture by Mr. Howard F. Weiss, on the subject "Structure of Commercial Woods in Relation to Their Injection With Preservatives," also papers by Mr. W. F. Goltra, Mr. R. J. Calder, Mr. J. H. Nelson, Mr. J. H. Waterman, Dr. von Schrenk and Mr. H. M. Rollins.

The use of reinforced concrete for snow sheds promises to make travel through the mountains of the West far safer than in the past few years. The Great Northern has completed 3,300 feet of concrete sheds at Wellington, Wash., where a passenger train was once swept from the track by an avalanche of snow.

CARBONDALE TIE-TREATING PLANT.

One of the largest timber treating plants in the United States is that of the Ayer & Lord Tie Co., at Carbondale, Ill. The main building is built of brick, concrete and steel, and the whole area covered by plant and tie yard is 180 acres. This immense area gives adequate room for the storage of ties until properly seasoned, and this with a capacity for treating from 15,000 to 20,000 ties daily. In the tie yards there is an aggregate of ten miles of track to provide the necessary track room for handling the ties efficiently. Ties are usually received in box cars and are unloaded directly into the piles where they remain until seasoned, at which time they are loaded onto the trams in shape to be taken into the treating cylinders. When ties are received which have already been seasoned, they are unloaded directly onto the tie trams, saving the cost of unloading and piling. The ties at this plant are furnished by the railways, and treated when received or after being seasoned, as specified. The railway is therefore responsible for the quality of the wood and also specifies the amount of preservative to be used. The function of the plant is to apply the preservative in the most efficient way in accordance with the specifications. The treatment and operations are at all times open to inspection by the railway which furnishes an inspector.

There are fifteen tracks in the tie storage yards. After unloading into a pile, each carload is marked with the car number and date of unloading. This system gives an accurate account of the length of time of seasoning.

Usually ties are not treated until thoroughly air seasoned. A short period of steam seasoning is advocated (not at high temperature, however), as it has been found that zinc chloride will penetrate better and will be retained better after steaming.

Decaying wood is not allowed to accumulate, but is removed and burned or sold for fuel.

Track scales are installed on the tracks leading to the treating cylinders, capacity one tram, and a few tram loads of ties out of each run are weighed, which gives sufficient data for the entire run. The trams used are of the ordinary type, with bales, furnished by the Buda Company, Fairbanks, Morse & Co., and the Kilbourn & Jacobs Manufacturing Co Practically all the movements of trams throughout the tie yards are accomplished by means of cables and drums, driven by electric motors.

Nearly all classes of wood are treated, including the red oak family, beech, ash, elm, gum, pine, cypress (except red); rea oak and pine are found to take treatment most easily, but all of the above mentioned woods are found to take the zinc chloride treatment very well.

Different timbers are grouped or classified for treatment, according to the specification of the railway for which the work is being done. When treating with zinc chloride it is calculated to inject ½ lb. dry zinc chloride in each cubic foot of timber. The ties remain in the cylinders for 8 to 12 hours, the time depending on the condition and structure of the timbers. The method of determining penetration or absorption is by gage readings.

Most of the ties at the Carbondale plant are treated with zinc chloride, although straight creosote is injected by the fuel cell or Rueping process.

The Rueping process differs somewhat from others. The following description of this process is extracted from a report submitted to the Railway Engineering Association:

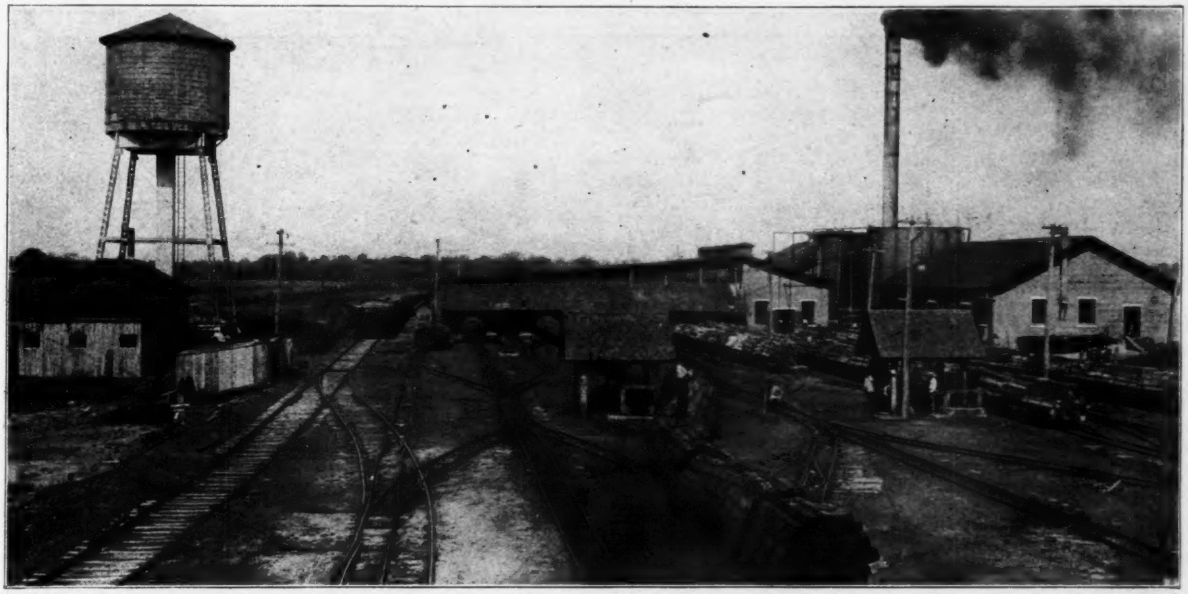
"Timber is preferably thoroughly air seasoned; green or partially seasoned timber is steam dried before treatment.

"The timber is subjected to an initial air pressure until the cells are filled; the impregnating fluid is then admitted at a still higher pressure.

"Plenty of time should elapse to allow the cells to be completely filled, before allowing the impregnating liquid to enter. Air is allowed to escape to make room for the liquid to enter.

"While the impregnating liquid is being introduced, it is necessary that the pressure be kept the same at all times, and the air escape valve is located at the top of the cylinder to prevent the formation of air pockets in the liquid. After the timber has been completely immersed in the liquid, additional liquid is forced in until the desired maximum is obtained. The pressure should increase slowly and uniformly.

"The maximum pressure should be maintained until the timber will not absorb any more appreciable quantity of the liquid. The pressure is then cut off and the liquid discharged. The amount of liquid absorbed by timber can be decreased by increasing the initial air pressure or decreasing the liquid pressure; that is, the final absorption is dependent on the relative differences between the air pressure and the impregnating liquid pressure. The main object of a vacuum in this process is to dry the liquid from the surface of the timber.



Ayer & Lord Tie Treating Plant at Carbondale, Ill.

This vacuum should be maintained until atmospheric pressure, or less, is established at least in the surface section of the timber, so that the timber is dry when it leaves the cylinder, and compressed air, which will escape for an hour or so, will not cause dripping."

The zinc chloride used at the plant is furnished by the General Chemical Co., and the creosote is imported. The company has an immense storage tank for creosote oil at Chalamette, La. This tank is so located that the creosote is emptied directly from the ship into it. The capacity is 1,364,830 gallons.

Ties only are treated at the plant, and they are handled entirely by hand; no lumber or piling is treated. The laborers at the plant are all paid piece work rates. There are eight cylinders in the plant, six of which have entrances at either end. The last two cylinders installed were single end. An inspector is maintained by the railway company, for which work is being done, and the work is subject to his orders, in so far as the actual treating process is concerned. The equipment of the plant includes:

Eight treating cylinders, 135 ft. long, with 6 ft. 2 in. interior diameter, furnished by the Allis-Chalmers Co., and the Reeves Bros. Co., Alliance, O.

Six boilers, 72x18 ins.

A large number of Dean & Worthington pressure and vacuum pumps.

Air compressors made by the Ingersoll-Rand Co.

All piping in the plant is cast iron. The first installation was steel piping, but this was replaced by cast iron, as the steel was rapidly eaten by the zinc chloride.

Power transmission is electric; General Electric generators are used.

Two Ideal 100 h. p. engines.

Five 37½ h. p. General Electric motors.

Five Lidgerwood hoist engines for winding up cables, which are used for all transportation in the plant.

Track scale and tram scale.

Working tank, 846,000 gallons capacity.

Water tower, 105,000 gallons capacity.

The capacity of the Carbondale plant is from 15,000 to 20,000 ties per day. Since the plant was completed in 1902 there have been treated 38,000,000 ties.

Transferring Ties as Received Directly from Cars to Trams for Treatment.

IMPROVED METHOD OF TREATING TIES AND TIMBERS.

By W. F. Goltra.*

The science of timber preservation by treatment with chemicals is one of the livest subjects before the American people today. Many problems in the art of treating wood with antiseptics have yet to be solved, and there is undoubtedly much room for improvement. From years of experience, coupled with careful study of this subject we conclude that much improvement over methods commonly employed in this country lies in the direction of a speedier and more efficient method of seasoning, a better preparation for impregnating ties and timbers, as well as greater economy in handling of the material. Despite the diversity of practice it is possible to find among the experienced and practical operators, both in this country and abroad, a measure of agreement as to both methods and results and from these to outline the essentials of a correct method. Sufficient data is obtainable to form a correct opinion as to the best preservative agents and method of treatment that should be employed to produce the best and most economical results.

It is our desire to submit for consideration, to those interested in timber preservation, a new and original method of treating ties and timbers with preservatives. Several distinct steps are taken in carrying out this new method consisting of:

a. Steaming of ties upon delivery at plant.
b. Stacking of ties in the yard for open-air seasoning.
c. Machining of ties preparatory to impregnation.
d. Completion of drying and warming ties in ovens.
e. Impregnation with antiseptic liquid.

Steaming of Ties.

Immediately upon arrival of the ties or timbers at the treating plants, they are transferred by hand from standard gauge cars to narrow gauge tram cars, which are placed alongside of the standard gauge cars. The loaded tram cars are run into the steaming cylinder. The cylinder is provided with a heavy cast-iron door adapted to slide up and down and close hermetically. It is operated by an electric hoist and can be lowered or raised in the space of one minute. The ties or timbers are subjected to live steam at a pressure of about 15

*President of the W. F. Goltra Tie Co., Cleveland, O.

lbs. per sq. in. for a period varying from thirty (30) minutes to four (4) hours, depending upon the character and condition, such as thickness of pieces, density of the wood, proportion of heartwood and sapwood, species of wood, moisture condition and the like. In most cases possibly fifteen (15) to twenty (20) pounds steam pressure should be the maximum, for reasons hereinafter set forth. It should not, however, be inferred from the above that it is necessary to separate ties or timbers into groups for steaming, beyond the natural separation at shipping point.

Now in order that the steaming step in the process may be clearly apprehended, both as to its own importance and its preparatory value for whatever is to follow, it will be observed that steaming the wood as above indicated has the effect:

(1) Of breaking the cell walls and producing narrow microscopical slits, through which the juices and saps in the cells and intercellular spaces are liberated. Slow steaming gradually heats the wood through antd through to the center of the piece, expanding the moisture of the cell into vapor, causing the juices in the wood to be rapidly expelled. Live and growing timber with its natural saps and its sap cells in their normal condition will resist the introduction of any fluid much on the same principles that bodies cannot occupy the same space at the same time. To be able to introduce any solution, under these conditions, the natural sap in the timber must, in some way, be first freed and expelled from the timber, either by being evaporated by drying, or forced out by steam.

(2) Steaming effects a great reduction of the time subsequently required for seasoning the wood, whether it be in a dry kiln with heated air or by natural air seasoning. It has been demonstrated that steaming lumber in a suitable chamber before entering the kiln will materially reduce the time for drying. Railroad ties, piling and similar heavy timbers will dry as much in two or three months after getting a preliminary steaming as they would in nine months to twelve months by natural air seasoning without steaming. For this reason stock carried can be reduced, saving about three-quarters of the capital that might otherwise be locked up in stock on hand, when the ties or timbers are not steamed. It further affects a material economy in the cost of installation of a treating plant by proportionately diminishing the storage yard space and length of tracks needed to handle the ties. Fire insurance and taxes are also correspondingly reduced.

The reason why cross ties and lumber dry so much more rapidly when subjected to a preliminary steaming pressure is that the saps and juices in the cells have been extracted and the voids filled with vapor, which evaporates far more rapidly than the saps when the material is subsequently exposed to the air for drying, and, in addition, the cell walls are broken and the wood liberates the vapor or condensed water very readily.

(3) Steaming dissolves and withdraws the juices and saps contained in the wood and prevents decay when subsequently dried. When green ties are piled for air drying without preliminary steaming, the saps and juices are liable to ferment and decompose rapidly, and the decay attacks the delicate cells and less compact portions of the timber, and then the firmer portions until, in a few months, the timber becomes spongy or doaty in the interior and its strength is impaired. In this condition it absorbs undue quantities of the preservative when treated. Timber that has reached this stage (usually called "over-seasoned") will absorb the preservative freely, but the excessive absorption is valueness and wasted. Steaming arrests incipient decay and destroys such fungi as may be contained in the wood. Its action abstracts and withdraws the saps, juices and organic matter upon which the germs of decay (which may be inherent in the wood) are supposed to subsist while the timber is air seasoning.

(4) Steaming softens the outer surfaces and opens the pores of such timbers as may have had a preliminary air seasoning and which may have become "case-hardened," thus permitting rapid evaporation of the moisture contained in the interior of the timber and thereby preventing much of the checking and splitting, which is so common in cross ties and timbers generally, while undergoing air seasoning. Many of the hardwoods "case-harden" when they dry rapidly in the open air without sufficient surrounding moisture; that is, the outer part shrinks before the interior has had a chance to do the same, and thus forms a hard shell or case of shrunken wood around the exterior. This shell does not prevent the interior from drying, but when drying the interior is commonly checked along the medullary or pith rays. In practice this occurrence can be prevented by steaming the lumber and then drying it, either in a kiln or in open air. Most of the checking and splitting of railroad ties while seasoning naturally in the open air is due to the inequality in drying. It has been observed that the ends of ties that are more or less exposed to the elements, check and split much more than other portions of the stick. This is mostly because the shrinkage which occurs when drying is not uniform throughout the piece. By giving the wood a preliminary steaming, which opens the pores and cells of the wood throughout, the drying will be more uniform, as well as more rapid. Consequently these defects are minimized and in most cases prevented, and the wood comes together more compactly and firmly than in ordinary air seasoning alone.

(5) The chief point in securing good treatment is to withdraw the juices, saps and acids from the timber. Hence steaming is an essential part in the process of treatment of wood, not only as to the effect on the timber, extracting the juices and toughening the fibre of the wood, but in a general way to prepare it to absorb the chemical preservative, whatever it may be. The slitting of the cell walls caused by steaming renders the wood more permeable and the slits do not reunite when the timber is submerged in the preservative. Professor Harry D. Tiemann, of Yale Forest School, United States Forest Service, made a very careful and original examination of the physical structure of wood in relation to its penetrability by preservative fluids, and the results of his findings are summarized by him in a report printed in the American Railway Engineering Association's proceedings of March, 1910, as follows:

"To emphasize the main principles established by his research the results will be stated in the following concise form:"

(1) All wood in the fresh green state is impenetrable to gases, even under high pressure, except through the open vessels in the angiosperms and the resin ducts in the conifers, where these are not clogged by tyloses or resin. The same is true as regards liquids, except that water solution may gradually seep through the membranes. Since it is the wood fibres and the tracheids which form the main part of the structure of the wood, impregnation of these vessels or ducts would be of little use of itself in preservative treatment. The above is due to the fact that every cell is a closed vessel, completely surrounded by its primary wall.

(2) Whenever wood seasons (beyond the fibre saturation point) whether naturally or by artificial means, narrow microscopical slits occur in the walls of the fibres and tracheids which render them permeable to gases and liquids. These slits do not reunite when the wood is resoaked, although they may close up somewhat. The greater the degree of dryness the more permeable the wood becomes.

(3) Steaming green wood produces a somewhat similar effect, but to a less degree, unless the wood is subsequently dried also. The reason then that absolutely green wood cannot be successfully treated with preservatives is due, not so much to the fact that the wood contains water, but because the cell walls are unbroken and therefore impenetrable. Just what pressure these walls would resist it is impossible to state, but it seems probable that it would run into the thousands of pounds per square inch.

In connection with this statement, it should be distinctly noted that by the immersion of green wood in hot oil the heat of itself may produce more or less seasoning and steaming, particularly if the oil is heated to 212 degrees Fahrenheit, which would, therefore have itself the tendency to open these slits in the walls also. Thus some penetration might be obtained with green wood in hot oil.

Among the species experimented upon were, longleaf pine, white pine, loblolly pine, red spruce, white oak, red oak, black oak, chestnut and tulip. Air and steam pressure up to 130 to 150 pounds per square inch were used in some cases. In not a single case was an exception found to the statements made in this article.

According to Professor Tiemann, air seasoning or steaming is necessary to open the slits in the walls of the cells of the woods which are otherwise impenetrable to fluids under pressure; and the slits or openings which permit entrance of the fluids to the cells, begin to appear when the moisture in the cell begins to dry out. He further observes that steaming green wood produces a similar effect as air seasoning, when wood is subsequently dried; and that the greater the degree of dryness the more permeable the wood becomes.

(6) Experiments under varying conditions indicate that large timbers, such as railroad ties, piling, etc., may be steamed at twenty pounds' pressure for as much as four hours without material reduction of strength. It is well known that if any wood is subjected to excessive steam pressure for a considerable length of time the wood fibre is disintergrated or pulped, and even under less pressure the strength of the wood is impaired. Even less time and pressure will release the coloring matter contained in the wood and render it pale, colorless and deficient of character, but it has been demonstrated that wood subjected to live steam under pressure not exceeding twenty pounds for a time varying from thirty minutes to four hours, according to kind and thickness of wood, distributes and makes the coloring of the wood uniform without impairing the strength of the wood. The milling and finishing qualities are thereby materially enhanced.

The duration of the steaming is determined by the color of the condensation from the cylinders. At first the condensed water runs off fairly clear and colorless, but later on it gets much darker and discolored and has a particular woody smell from the extracts dissolved. Steaming is continued until this stage is passed and the condensed water again runs clear and colorless, showing that the sap has been dissolved and withdrawn to the fullest extent possible.

The moisture in timber amounts to from sixteen to sixty-five per cent. It is unequally distributed in green timber, being greatest in the sapwood. The per cent of moisture present in different kinds of wood is approximately as shown in the accompanying table:

	Sapwood or outer part.	Heartwood or interior.
Pine, cedar, spruce firs..................	45-65	16-25
Cypress, extremely variable	50-65	18-60
Oak, beech, ash, maple, elm, hickory, chestnut, walnut and sycamore.............	40-50	30-40

The lighter kinds of woods have the most water in the sapwood, thus sycamore has more than hickory.

It is manifest that the greater part of the moisture must be removed in order to put the timber in condition to receive treatment with antiseptics. While it is true that by long continued exposure to open air timber can be sufficiently dried to meet common requirements, it is evident that such methods require too much time and space to meet modern conditions. What is more, ties and timbers air seasoned without preliminary steaming are not in reality dry even after many months of exposure; and their remaining moisture is too unevenly distributed to insure good behavior during impregnation.

When steaming sawed ties or lumber, the pieces should be piled on cross sticks about one inch apart horizontally, so that the steam will have access to all surfaces. The steam pressure should be only a few pounds at the beginning and gradually increased to not exceeding twenty pounds at the end of the operation, so as not to heat the timber too suddenly. Rapid heating may cause checking and splitting, an effect which frequently occurs when hot oil is introduced in the retort on cold ties.

Experience has demonstrated that it is not feasible to impregnate timbers with antiseptics immediately following the steaming, because the cells are filled with vapor and condensed steam, which resist the entrance of the chemical. A fair penetration can be obtained with zinc chloride, but scarcely any at all with creosote oil. It is very essential that the ties and timbers be dried after the steaming.

(b) Stacking of Ties in Yard for Air Seasoning.

After steaming the ties the loaded tram cars are drawn out of the steaming cylinders by a small locomotive or any suitable means. A transfer table, operated by power, is very advantageously used to place the ties on one of the parallel yard tracks and the tram cars are drawn to the place where the ties are to be stacked. The time required to transfer the loaded trams from the steaming cylinders to any point in the yard is about five minutes, and the transfer table greatly facilitates the handling of ties in the yard. The tracks in the yard are laid double, and each has three rails. With this arrangement a standard gauge locomotive crane can stand on one track and unload narrow gauge tram cars standing on another. The use of the locomotive crane and transfer table effects great economy in time and labor. The cost of labor for unloading, steaming, and stacking in the yard, is less than when the ties are stacked directly from the standard gauge cars, without the crane and transfer table. Furthermore the use of a locomotive crane and transfer table materially reduces the cost of building a plant as the arrangement of the yard thereby made possible, affords a better utilization of the space for stacking ties, lessening the space required and correspondingly lessening the length of tracks; it also eliminates the expense for the construction of a high loading platform, as the treated ties are transferred for shipment directly from tram cars at yard level to standard gauge gondola cars. The space required for a plant having the capacity for treating upwards of one million ties annually is about twenty acres and the length of tracking in the yard is approximately four miles. The ties should be piled in such a manner that the air will have free access to all surfaces and a good way to stack ties for seasoning is to pile them by what is known as one by eight, running the stacks fourteen to sixteen feet high, which can easily be done with a locomotive crane.

As previously stated, ties which have been given a preliminary steaming dry rapidly, and the average time required to put them in condition for treatment is about three months, depending upon the character of the wood and climatic conditions. Ordinarily it requires from nine months to twelve months in the open air for ties to season sufficiently for treatment.

(c) Machining Ties.

When the ties have sufficiently seasoned and are ready for treatment, they are taken from the piles, passed through an adzing and boring machine and loaded directly on tram cars to be transported to the ovens for the completion of the drying, thence to the impregnating cylinder for treatment with preservatives.

The adzing and boring machine is preferably mounted on a standard gauge box car, which is moved about the yard and placed opposite the stacks of ties. A skid is placed between the stacks and the car on one side, and another skid is placed between the machine car and tram cars on the other side. In loading ties on tram cars, care should be exercised to pile them loosely, both vertically and horizontally, to permit the heated air in the ovens, as well as the preservative fluid in the retorts, to come in contact with all surfaces. If the ties are sawed the parting strips should be about one inch thick to keep the surfaces apart. It is not absolutely necessary to use parting strips for hewed ties. The yard tracks are arranged so that the machine car can be placed on one track and the tram cars on the other, which enables the machining of ties to be performed in the most economical manner.

There are two causes of tie deterioration; decay and mechanical wear. There is no economy in increasing the resistance of one without also increasing the resistance of the other.

Of these two destructive agencies decay is much the greater, but it is so interwoven with mechanical wear that the two should be considered together. Heavy rails and the use of tie-plates are only partial preventives of mechanical abrasion and do not reach the chief causes of mechanical destruction. Under existing conditions, the greatest possible life and efficiency of ties is not obtained by American railroads and to a large extent this failure is due to two causes, i. e.; (1), ties are not properly seasoned for treatment with antiseptic; (2), ties are not properly prepared for service in track. I have already given attention to the first cause and will now consider the second.

It has been almost the universal practice on English, French and several European railways, to machine cross ties before attaching the rails or rail chairs to them. The consensus of opinion of Europe is to the effect that such preparation is of marked economy. Years of observation and tests on both treated and untreated ties, have proven that longer life is obtained by the machining operation. The majority of ties, either hewn or sawn, are somewhat winding when placed in the track, and hewn ties may offer a very irregular surface for one or both rails. A tie which does not offer a plane surface for the base of each rail will work in the ballast, has a smaller load bearing capacity and increases cost of track maintenance. The tie seats for both rails should be in the same plane. Few sawn ties even, present bearing surfaces to the rail that are in the same plane. Most ties, whether sawn or hewn, are either bowed or winding, and in either case the rail crushes down the wood at the high contact point. The machining of ties obviates the necessity of adzing them before laying in the track, thereby effecting a saving in the time and labor of the section men. It should be borne in mind that during the time that ties are air seasoning, some distortion in shape will occur.

In fastening a rail to a tie, either a cut spike must be driven, or a screw spike must be turned into the tie structure. If a screw spike be used in any form now on the market, it is absolutely necessary to first bore a hole for it to enter. If a cut spike be used it is possible to drive it in most of our American tie woods without previously boring a hole; but even though it is possible to drive a spike without boring first, it has never yet been proven advisable to do so. Skilled wood workers and mill-wrights know that the holding of a heavy spike is greater when it follows a small hole than when driven directly into the wood structure. They also know that each spike can be relied upon for an average holding power when it is driven to follow a hole, because it will not open cracks nor lead off into checks nor dodge the knots. It has been demonstrated that a spike driven into a bored hole has also much greater resistance to lateral pressure because it has the backing of the more solid wood, instead of broken and distorted fibres. Tests of 9-16-inch square spikes driven into 7-16-inch round holes, show much more uniform as well as greater holding power than 9-16-inch spikes driven directly. With the usual method of driving a cut spike into the tie, there is excessive mutilation of the wood fibre along the body of the spike, and a mass of crushed fibre forced forward at the point of the spike. In many cases it actually splits out in large sections in the lower half of the tie and in many more cases it causes serious checks. Furthermore, the boring of ties to be treated is very essential because the holes become mediums through which chemicals reach the interior of the ties and penetrate radially from each hole, thus promoting impregnation. In consequence also, the spike never opens the grain of the wood beyond the penetration depth.

A tie when properly seasoned, adzed and bored, properly treated with antiseptics, has received the most perfect protection at every point against the destructive agencies of decay.

It is essential to know the date when ties are treated. Some railroads affix galvanized dating nails. This method is expensive and unsatisfactory. Instead of using dating nails a pneumatic branding device consisting of two opposite cylinders with pistons, provided with dies for stamping dates, or any other information may be used. The stamping device is controlled by automatic air valves, may be placed directly behind the boring spindles and so timed to the machine feed that when the tie moves to the proper position the dies advance and leave their deep sunken impression in both ends of the tie.

(d) Completion of Drying and Warming of the Ties in Ovens.

After the ties have been machined and loaded directly upon tram cars, they are transported to the drying ovens and from thence to the impregnating retort hereinafter described.

The moisture content in timber has a very appreciable effect upon the way in which it lends itself to treatment. Any method that will place the wood in such good condition that it will be approximately the same moisture condition throughout, is bound to result in a much more uniform penetration and dissemination of the antiseptic than can be obtained where such favorable conditions do not exist. Uniform distribution of preservative through the wood is one of the cardinal principles of proper wood preservation. Slow air seasoning is not found sufficient to insure a good preparation of ties and timbers for treatment and the drying should therefore be completed in the ovens. In France some of the treating plants are equipped with drying ovens and the seasoning of ties is completed just prior to the treatment with antiseptic. In this way, it is claimed that a much better penetration and a more uniform distribution of the antiseptic is obtained.

Different woods absorb heat with different degrees of rapidity, depending principally upon the conductivity of their fibres. It has been demonstrated that an average of twenty-four hours is sufficient time to heat timbers, such as railroad ties, through and through, and during this time the moisture content will be reduced three to four per cent. Of course, the timber will lose a much greater percentage of moisture during the air seasoning period, depending upon the length of time it is exposed to the open air and climatic conditions, but the object in placing it in ovens is not only to complete the air drying, but for two other very important reasons, namely, (1) it permits a perfect regularity of operation at the plant in all seasons of the year and in all kinds of weather, and (2), the timber thus dried comes to the impregnating retort in a hot condition and the high temperature of the impregnating fluid, when introduced into the retort, is maintained when it comes in contact with the wood, consequently the penetration is deeper and more perfect. During the winter season, especially in the Northern latitudes, it is frequently necessary to close down the works on account of ties being covered with ice and snow. When such ties are placed in the retort for treatment the warm impregnating fluid is chilled and congealed and, in consequence the penetration is very slight. Again, ties exposed to the weather immediately prior to treatment are often drenched by heavy rains and absorb considerable water. This offsets the air seasoning in some measure and makes it quite impossible to obtain good results from such seasoning alone. But with ovens it is possible to get prime conditions preparatory to antiseptic treatment, and also hurry the seasoning of any timber which might be urgently needed.

When drying wood in the ovens, whether in the form of railroad ties, standard stock, or finishing products, the application of the requisite heat and circulation must be carefully regulated throughout the entire process, or warping and checking are certain to result. Again, sticks of different shape and thickness are very differently effected by the same treatment. Finally the tissues composing the wood, differing in form and physical properties as they do, and crossing each other in

various directions, exert their own peculiar influence upon the behavior of the wood during the drying. For instance, with our native woods, summerwood and springwood show distinct tendencies in drying, and the same is true in a less degree of heartwood and sapwood. Or again, pronounced medullary rays further complicate the drying problem. Thus some woods yield their moisture more readily than others, so that the time for drying differs widely with the species as well as with the intended use. The rapidity with which the drying can be carried on, after the material has received a preliminary steaming or air seasoning, therefore depends upon several factors such as species of wood, its softness and porosity, proportion of heartwood and sapwood, hardness and density, size, mass, intended use, and the manner in which it is presented to the air in the ovens. No positive rule can therefore be given as to the duration of the drying period and the temperature for the various kinds of woods under all conditions, but experience soon teaches the operator how rapidly the ties or lumber can be dried in the ovens without splitting, checking, warping or honeycombing.

It should not be inferred from the above that it is necessary to separate railroad ties into groups for drying in ovens, beyond the natural separation at shipping point. As the time required to obtain sufficient dryness varies, on account of the factors above mentioned, such ties or timbers as have first reached totality of dryness, should wait in the ovens for the more refractory timbers. The time required in the ovens to complete the drying of railroad ties, which have undergone the several preceding steps, is from eighteen to thirty hours, or an average of twenty-four hours.

The drying oven is preferably built of masonry and corresponds in length and size to the length of the impregnating retorts. The air is heated by means of heating coils, placed under or in the bottom of the ovens. and the circulation of the air is effected by means of a blower or fan. Fresh air enters at the ends of the ovens, passes through the heating coils, thence in the oven chambers, thence through the loads or charges on the trams, to the opposite end of the ovens, thence downward into the moist air duct, thence into the moist air gallery from whence it is drawn out and exhausted by means of the blower. Each oven is adapted to be operated independently of the other, so that when one or more ovens are being charged, the others are not affected. The velocity of the air is regulated by means of dampers and a blower or fan. The blower is operated by an engine. One damper for each oven is situated at or near the entrance of the fresh air in the heating chamber and the other at the exit of the moist air into the moist air collection gallery. The temperature of the air is regulated by means of valves situated near the heaters for each oven. Therefore, the velocity and temperature of the air are under absolute control at all times. The free air space between the loads and the cylindrical walls in the oven is only sufficient for clearance, say about three inches, so that the air will pass through the loads and come in contact with all surfaces of the material, instead of passing around it and drying and warming the exterior more than the interior. At the beginning the temperature of the ovens should be about ninety-five degrees and gradually raised to one hundred and fifty to one hundred and seventy-five degrees Fahrenheit. A maximum temperature of two hundred and thirty-six degrees Fahrenheit may be attained, with a boiler pressure of one hundred pounds.

In the basement of each oven there is a ste front, with a swinging door, and there is also a small cast iron door in the walls between the working gallery and the moist air gallery. These doors are for the purpose of ventilating the working galleries. By opening the two doors a current of fresh air can be made to pass through the working gallery into the moist air collection gallery.

The transfer from the drying ovens is quickly made by means of a transfer table and no appreciable amount of heat is lost while making the shift from the ovens to the impregnating retorts. It has been popularly supposed that in operations on a large scale it would involve considerable increased expense to move the ties from the steaming cylinders to the drying yards and from the drying yards to the drying ovens, and then from the drying ovens to the impregnated retorts. This is incorrect. On the contrary, by means of the transfer table and the locomotive crane, the cost of handling ties and lumber may be approximately reduced in most cases.

Green timber fresh from the saw can be treated as readily as older stock; sometimes apparently more readily, so that preliminary air seasoning may be dispensed with. Thus, this system of steaming and drying ties or lumber may be employed with or without a treating plant adjunct.

(e) Impregnating with Antiseptic Chemicals.

After the timbers have remained in the ovens a sufficient length of time to thoroughly dry and warm them, the trams are drawn out onto a transfer table and immediaetly run into the impregnating cylinders for chemical treatment. The length of the cylinders corresponds with that of the drying oven and each cylinder should be capable of holding twelve tram loads of eight-foot ties, each tram carrying between forty-five and fifty ties, or approximately five hundred and sixty ties per charge.

The duration of diverse phases of one complete operation is as follows:

(1) Charging the cylinder with ties............15 minutes
(2) Producing vacuum to 14 inches..............45 "
(3) Filling cylinder with preservative............15 "
(4) Continuation of filling with pressure pump.....90 "
(5) Returning surplus preservative to working tank.15 "
(6) Producing vacuum to hasten drying of ties....30 "
(7) Blowing back last remnant of preservative to working tank..............................15 "
(8) Opening door and discharging cylinder........15 "
Total 240 minutes or four hours.

The first step is to produce a vacuum up to 14 inches of mercury and which should be attained within thirty to forty-five minutes. This is for the purpose of withdrawing some of the air from the cells and pores of the wood and inducing absorption of the preservative. The vacuum having been on for sufficient time it is held while the preservative is allowed to flow in, which it does very rapidly by the help of the vacuum and by gravity, until the impregnating cylinder is completely filled. It is understood that the preservative, whether it be creosote, chloride of zinc, or a mixture of the two, has been previously heated by means of coils in the respective tanks to a temperature of one hundred and seventy-five degrees Fahrenheit. (The solution pipes from the working tanks are connected to a dome in the bottom of the cylinder.) When the air pressure in the impregnating retort reaches the atmospheric pressure, as shown by the vacuum gauge, an air valve with an overflow pipe attached is opened to let the air escape from the retort, while filling. As soon as the fluid begins to flow in a full stream through the overflow pipe, indicating that the retort is full, the air valve is closed. When the cylinder is filled and the air pipe closed, the force or pressure pump is put into action and kept working until a pressure of say one hundred pounds per square inch is obtained. The more the preservative penetrates into the wood, the heavier the load on the force pump to maintain the necessary pressure. The impregnation is considered complete when the manometer shows, for at least twenty minutes, that without further pumping the pressure has remained stationary at one hundred pounds—thus showing that the chemical is no longer penetrating into the wood.

The duration of this phase of the operation varies from one

to two hours, depending upon many factors such as species of wood, physical structure, proportion of heartwood and sapwood, degree of seasoning, size, shape, mass, etc., not a single one of which is sufficiently well defined to make it possible or practicable to segregate timbers into many groups for treatment. The treatment should in all cases be carried to "refusal," which obviates the necessity for sorting ties or timbers into numerous groups and this is the only way to secure complete and thorough impregnation. The matter of first importance is to secure a thorough penetration. The matter of quantity and cost of antiseptic is a secondary consideration. The pressure should not exceed one hundred pounds per square inch, or it is liable to injure the fibre of the wood. Some experienced operators claim that high pressure splits the wood along the medullary rays and is otherwise detrimental to the fibre of the wood. At any rate, it has been found that high pressure plays only a secondary part, when precaution has been taken to secure thorough and complete seasoning of the ties and previous warming in the ovens to the temperature of the chemical with which they are subsequently treated. The pipe connections between pumps, tanks and impregnating cylinders should be arranged for treating with either straight creosote, straight chloride of zinc, or a mixture of the two ingredients. When a mixture of creosote and chloride of zinc is used, it is kept in agitation in the working tanks by means of steam jets and the fluid is kept in constant agitation in the impregnating cylinder while the pressure pump is working, by means of a circulating system operated by a centrifugal pump.

When the timber has absorbed all of the chemical possible, the pressure pump is stopped and the solution valve opened. At the same time the air compressor pump which is connected with the dome on top of the impregnating cylinder, is put into action, pumping air into the cylinder and forcing the excess chemical back to the working tank from which it was originally drawn. The solution valves are then closed and a vacuum is created in the cylinder by means of a vacuum pump. This vacuum, which need not exceed fourteen inches, is held about thirty minutes or sufficient time to allow the ties to drip. This phase of the operation is for the purpose of removing the surplus fluid remaining on the surface of the ties or timbers, so that they can be handled more comfortably, and also prevents subsequent dripping when drawn out of the cylinder. The vacuum reduces the air in the cylinder a little, and the cooling and condensation of the remnants of gases and vapors in the wood cells produce a vacuum suction to which is added the force of capillarity, drawing the preservative deeper into the wood.

When ties or timbers attain a sufficient degree of dryness so that they can be handled comfortably, the vacuum is released and the drippings returned to the working tank. This is accomplished by a "blow-back" system of piping. The air compressor pump is again put into action, forcing air into the cylinder and at the same time a blow-back valve is opened and the cylinder is thus cleared of the last remnant of solution, which is carried to the proper working tank by an overhead pipe. This completes the treating operation. The doors being opened, the tram loads are drawn out and placed on a track in the yard where they are transferred to standard gauge gondola cars.

The pressure pumps are connected with 7,500-gallon measuring tanks, which have gauges operated by floats. These gauges accurately show the volume of liquid forced into the timber by the pressure pump. The working tanks are also provided with gauges operated by floats. The indicators on the tanks are read at the beginning and end of each operation and the difference in the readings gives the volume of the chemicals used.

Yard Arrangement.

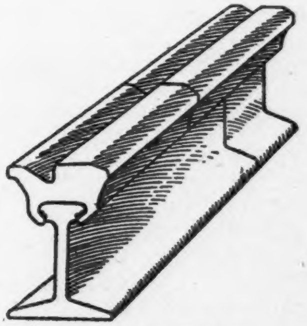
A new and original feature of the suggested plant is the entire absence of switches for running trams from one part of the yard to the other and from track to track. Frequently the room or space where a plant of this kind must be located is limited, and space precludes the possibility of building a plant of the ordinary kind with switches. We have planned a yard in which all of the tracks are parallel and relatively near to each other and which are crossed by a transfer table, adapted to move back and forth and serve all tracks abutting thereon. The space required for a plant of this kind is about one-third less than required for the ordinary type. The quantity or length of the tracks is proportionately reduced. The plant is more compact and considerable saving in time and labor can be effected on that account. The maintenance and depreciation of tracks is materially reduced and finally the entire cost of the plant entirely equipped for the preserving method described, is actually less than that of the plant of the ordinary type with equal capacity. The reduction of stock of ties necessary to keep on hand is of very great importance, not only in releasing the capital that is locked up in ties while undergoing air seasoning, but in reducing to a minimum the losses which occur through deterioration of ties while they are air seasoning.

Ordinarily, for a plant having a capacity of 1,000,000 ties or upwards, six drying ovens would be sufficient. However, if it was found that a larger number was required, they could easily be installed in groups of five each between the double parallel tracks. A plant might therefore be equipped with a sufficient number of drying ovens to receive all the ties and dispense with the open air treatment, but the original cost of the plant would necessarily be proportionately increased.

COMPOSITE RAILS.

The two companies operating street railways in Chicago are said to have each ordered composite rails sufficient for two miles of track, following successful working tests of this type of rail in England and France. These rails, which will be used on curves and stretches where the traffic is heaviest, are rolled in two sections, lower and upper. The lower section has the appearance of a T rail with a small flat head, and is spiked or bolted to the ties in the usual way. The upper sections are then crimped or pressed on by a machine, and are superimposed in such a way as to break joints with the lower section.

The staggered joints of the composite rail make a smooth track, all fastenings are dispensed with, no fish-plates, bolts, angle bars, or sole-plates being required; no electrical bonding is necessary, and when the upper section is worn out, a machine cuts it off and crimps on a new top section, saving about half the weight of metal used in renewals, and, in the case of uncovered T rails, making other disturbances of the permanent way unnecessary. Where the rails are laid in streets and are covered to the level of the pavement, only 6 to 8 in. of pavement need be disturbed in renewals.



Composite Rail.

PANAMA R. R. RELOCATION AND CONSTRUCTION.*

At the beginning of the fiscal year all grading on the relocated line from Gatun to Gamboa was practically complete, excepting that portion of the line in the main valley of the Gatun river and its tributaries. This section extends from the Gatun Ridge across the valleys of the Quebrancha, Brazo, Baja, and Gatun rivers, a distance of 3 miles. These valleys are all low, ranging from elevation +20 to elevation +35 above mean sea level, and in the aggregate contain about 4,000,000 cu. yds. Five hundred and seventy thousand five hundred and twenty-one cubic yards were placed last fiscal year, and in the 12 months of the present fiscal year 2,623,183 cu. yds. have been placed. There remained on June 30, 1911, about 850,000 cu. yds. to complete this section of the line.

The following statement shows the present condition of the four large embankments crossing the Gatun Valley:

Name.	Height, Feet.	Total yards.	Total to date.	Balance to be placed.	Per cent completed.
Quebrancha, 1,704 feet..	71	840,405	653,505	186,900	78
Brazos, 4,282 feet.......	60	1,598,936	1,112,036	486,900	70
Baja, 1,490 feet........	67	570,925	495,925	75,000	87
Gatun, 5,458 feet........	62	957,238	932,238	25,000	97

Borrow Pits.

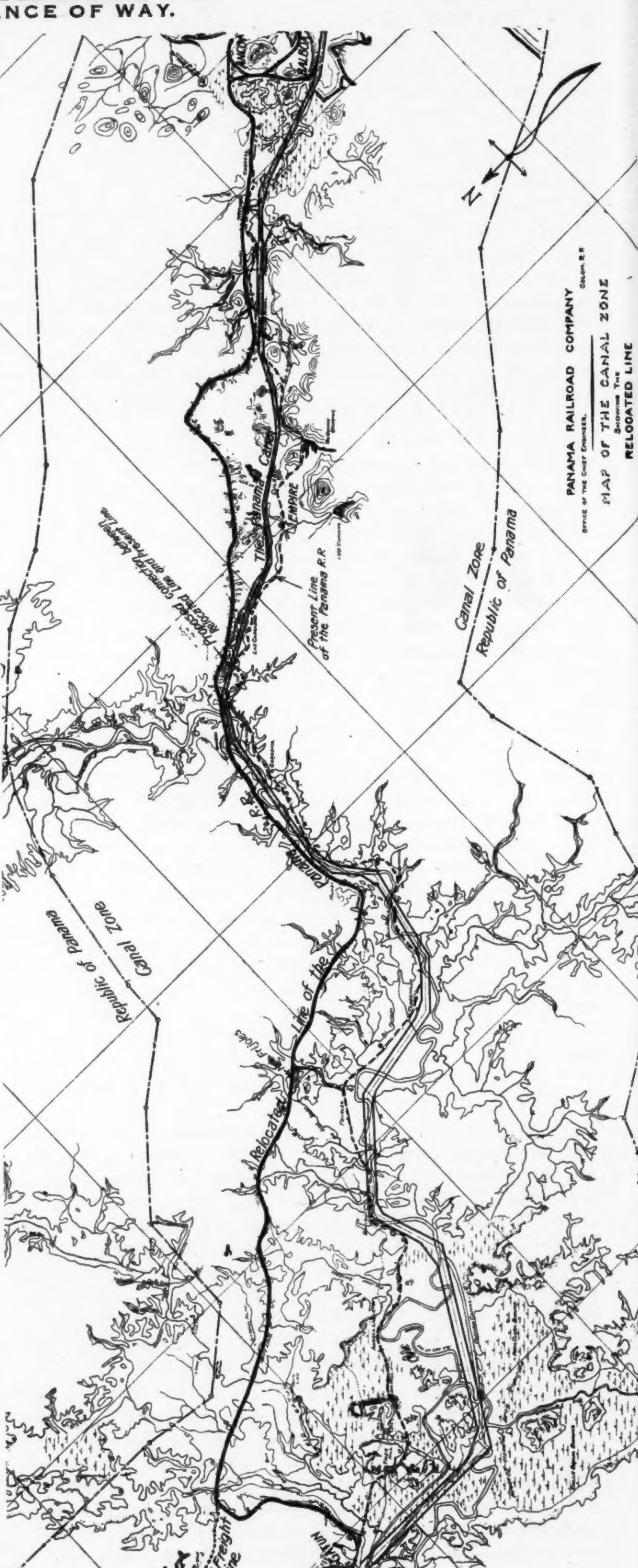
A few main line cuts remained to be excavated at the close of last fiscal year, and this yardage was all used in building the embankments across the valley. The greater part of the material for these fills was secured, however, from borrow pits. Early in the season several large borrow pits were opened up in close proximity to the dumps, and these have been worked throughout the year. The steam shovel output from these borrow pits has been particularly gratifying. In July, 1910, one model 91 Marion steam shovel was cut in, and in January, 1911, two other model 91 Marion steam shovels were secured to replace steam shovels of the 70-ton class.

Slides and Settlements.

The soundings over the bottom lands showed varying conditions. The ground level of the Quebrancha bottom, at station 330, is at elevation +20, while the soundings show it to be from 150 to 180 ft. to solid rock. The rock is overlaid with a soft deposit of sandy clay, with a harder stratum of clay and pure sand near the ground surface. The first deck of this embankment was put in to elevation +50 and filled well over the entire area out to the 2:1 slope stakes. A trestle was then driven at elevation +70, and filling from this level was started when a small settlement occurred on the line of the trestle, with corresponding upheaval of the natural ground beyond the slope stakes. This ground was further counter-weighted by filling in well beyond the slope on both sides, and the work of raising the center line to permanent grade was later continued. In this manner, by keeping careful watch on the settlement and upheaval, the permanent embankment has been brought very close to permanent grade at elevation +92. There has been no settlement on the Brazos bottom so far, and in some places the embankment is within 8 ft. of permanent grade.

The Baja bottom at station 420, however, has continued to give a great deal of trouble. The elevation of the natural ground at this point is +25, and it is about 60 ft. from top of ground to solid rock. The material intervening is the softest kind of clay, decomposed wood and vegetation. The weight of the filled-in earth and rock has pushed away the softer material and practically settled to bed rock. This embankment is now within 10 ft. of grade, with a heavy counterweight on either toe, and it is anticipated that it can be completed within a short time.

A small settlement occurred at the south end of Gatun river valley in the month of June. This embankment was



Panama R. R. Relocated Line. Old Line Shown Dotted.

*Extracted from the 1911 Annual Report of the Isthmian Canal Commission.

Placing Counterweight to Prevent Upheaval of Earth Adjacent to Toe of Fill, Quebrada Baja Bottom.

raised to grade +97 to conform to the permanent bridge at this point, and the excessive weight caused a small slide to develop along the west toe, which rolled and pushed up the natural ground for a distance of 200 or 300 ft. This upheaval has now been filled over and counterweighted and no further trouble is anticipated.

Permanent Bridge, Gatun River.

The reinforced concrete piers, shown in an accompanying illustration, for the permanent bridge at the Gatun river were built during the months of January, February and March. These piers are designed to carry the three new plate girders which now form the north spans of the Barbacoas bridge in the operated line. A creosoted pile bridge was driven along the west side of these piers, to be available for operation during the dismantling of the Barbacoas bridge and the erection of the girders at this point.

Pier No. 3 will be used for trunnion pier for a bascule bridge. It is proposed to convert one of the old plate-girder spans into a lift span during the next fiscal year by the installation of lifting mechanism. This bridge will thus provide for free access to the east arm of Gatun lake, with a channel 85 ft. wide and minimum depth of water of 45 ft.

Gold Hill Line.

Under the original plans for the construction of the new Panama railroad through the Culebra Cut, it was the intention to locate the new line on a 40-ft. berm at +95 level. Due to numerous slides which developed along the east side of Culebra Cut and which would threaten a track in this location, a board consisting of Mr. H. H. Rousseau, chairman, Maj. Chester Harding, member, and Lieut. Frederick Mears, member, was appointed by the chairman and chief engineer to consider the matter and make recommendations. This committee in a report dated July 23 recommended that the berm line through the Culebra cut for the permanent railroad be abandoned, and that the so-called high line around Gold Hill be adopted. Some of the reasons which led the committee to make this recommendation, as set forth in the report, are quoted below:

1. The disadvantages and inconveniences arising from the difficulty of access with such a "berm-line" track so far below the level of the natural ground between Gamboa and Pedro Miguel have become more pronounced and have assumed much larger relative weight.

2. During the present rainy season, as the excavation in the cut has gone deeper, the difficulty of keeping the berm-line road free from interruption before the banks have taken their final slope, which can not be expected to occur until some time after the completion of the canal has become more evident, and is now a potent factor in considering this question.

3. With a high line for railroad traffic and a berm line for construction and maintenance work only, the committee believes that the omission of the greater part, if not all, of the concrete retaining walls through the cut, the construction

Quebrancha Bottom, Panama R. R. Relocation.

Looking North from the Brazos Bottom.

of which was originally contemplated, can be seriously considered. These retaining walls could only be built at a large expense, and there is some doubt as to their necessity and permanent value. The estimate of December, 1908, included an item of $4,000,000 for these retaining walls.

All of these reasons, therefore, indicated the economy and desirability of running the relocated line, Panama railroad, on the so-called high line around Gold Hill.

Field Location.

This report having been approved July 26, 1910, steps were taken to make the necessary field surveys. Inasmuch as there were five locating parties soon to be available from the Panama government survey, no new engineers were secured to make these surveys. It was decided to utilize the first available party released from the Empire-David Survey for work on the Gold Hill line. A careful field reconnoissance was made over the entire area by Mr. Frederick Mears, chief engineer, and Mr. H. P. Warren, engineer of construction. The problem was to locate a line connecting the south end of Gamboa bridge, at the Chagres river, with the completed portion of the relocated line near Pedro Miguel. It was necessary to locate the new line well away from the east edge of the Culebra Cut, in order to be beyond the menace of any of the numerous slides. Preliminary reconnaissance and careful study of available maps showed three critical points, namely:

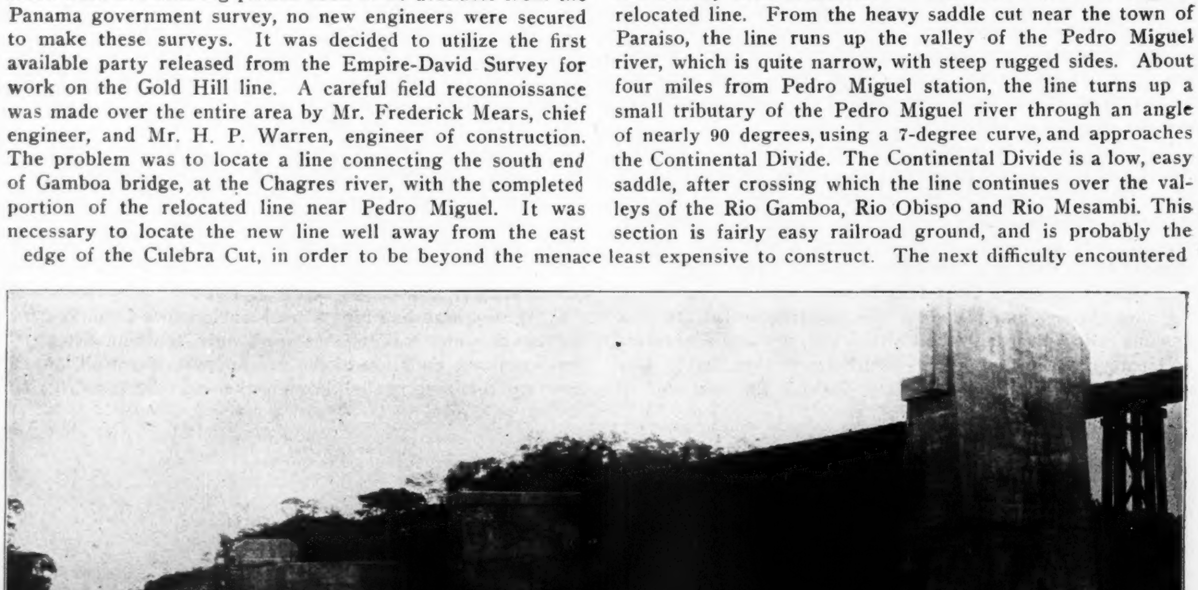
First. The section from Gamboa bridge south, which involves getting out of the canal section at the north end of the Culebra Cut, and reaching the high level of the natural ground along the east bank.

Second. Crossing the La Pita Divide. The La Pita ridge lies perpendicular to the general axis of the canal, forming quite an obstacle for any road crossing that section.

Third. Crossing a high divide near the town of Paraiso.

The map herewith shows the general topography of this country, as well as approved final location.

A field locating party started work about Oct. 1 at Pedro Miguel, and running north, carried the preliminary line to the Gamboa bridge. At first it was the aim and intention to keep this line close to the diversion track built by the Central Division in order to facilitate construction and the delivery of construction material, but it was early decided to adopt a 1¼ per cent grade, and locate the line independently of this track, in order to secure a roadbed benched in on the solid ground, beyond the sphere of any influence of slides in the Culebra Cut. The surveys were commenced at the south end because it was extremely desirable to secure a location in close proximity to the present towns of Paraiso and Pedro Miguel. Field work soon developed the fact that by using 1¼ per cent. grade northbound, and taking an exceedingly heavy cut in the ridge back of Paraiso, a suitable line could be secured which would lie close to the towns above mentioned, as well as take advantage of a mile of track which had already been constructed in connection with the original relocated line. From the heavy saddle cut near the town of Paraiso, the line runs up the valley of the Pedro Miguel river, which is quite narrow, with steep rugged sides. About four miles from Pedro Miguel station, the line turns up a small tributary of the Pedro Miguel river through an angle of nearly 90 degrees, using a 7-degree curve, and approaches the Continental Divide. The Continental Divide is a low, easy saddle, after crossing which the line continues over the valleys of the Rio Gamboa, Rio Obispo and Rio Mesambi. This section is fairly easy railroad ground, and is probably the least expensive to construct. The next difficulty encountered



Reinforced Concrete Piers for Gatun River Bridge, Panama R. R. Relocation.

Gold Hill Relocation, Panama R. R.

is the crossing of the range of hills dividing the basins of the Rio Mesambi and the Rio Sardinilla, commonly called the La Pita Divide, from the name of one of its prominent hills on the canal slope. Lines were located through several saddles, and the one finally adopted lies about one mile east of the canal axis. From the Rio Sardinilla the located line skirts the base of a very high range of hills for about one mile, and crosses the diversion of the Rio Obispo on a triple 20 by 10 concrete box. This diversion was built by the canal commission to divert the waters of the numerous streams on the east side of the cut and carry them into the Chagres river, above the Gamboa bridge. The crest of the grade was reached at Station 1549, near the La Pita Divide, which is at elevation plus 270. The line from the Gamboa bridge to the La Pita Divide was built on a practically continuous plus 1¼ per cent grade, southbound, and the line so located as to interfere as little as possible with the movement of the Central Division spoil trains, over the Gamboa bridge. Final location for this line was completed about Feb. 1, although construction over other settled portions was undertaken before this date.

The usual difficulties incident to railroad location in a tropical country were encountered on these surveys. Progress was limited by the amount of line which the machete men could cut out in one day, varying from three to six thousand feet, depending upon the character of the jungle. All topography was taken by accurately locating contours on 10-ft. vertical interval. The sickness among the men made frequent changes in make-up of the parties necessary. This was largely due to the fact that these men had been on the Panama government survey for some months in the tropical jungle, and away from good medical attention.

From the increased knowledge of the country, gained during the construction, only minor changes of alignment have been necessary, and these were all put into effect before construction work was started. It is believed without question that we have secured the best line that the country affords.

Construction.

Construction was commenced Jan. 1, 1911. The work was greatly aided by the fact that experienced foremen were available from other sections of the relocation, and by the proximity to a large part of the work of the Isthmian canal commission's diversion track.

On the whole line, the cut and fill about balance at 1,125,000 cu. yds. There were 9,000 cu. yds. of concrete to be placed in culverts, and 2¼ miles of temporary trestle to be driven. The length of the line is 9⅜ miles. Of the grading, about 275,000 cu. yds. were hand work, the remainder steam shovel work. The grading was placed in the hands of Mr. M. B. Connolly, superintendent of construction, who is in charge of the same work on the rest of the relocation. A bridge and culvert department was organized with Mr. Ed. Slayback, as supervisor, and the engineering was left in charge of Mr. L. K. Needham, who had charge of location.

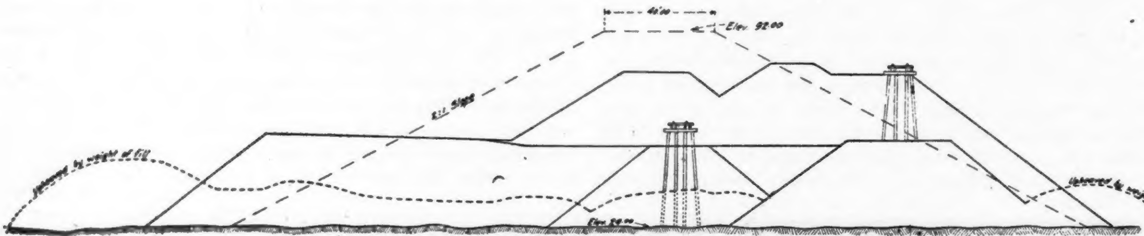
Gold Hill Line, South of Contractor's Cut.

A small section of line between the Obispo diversion crossing and the Rio Sardinilla was let by contract to Mr. J. B. Hull. This consisted of about 75,000 cu. yds. of hand work, and was to be finished by Aug. 1, 1911. A flat price of 57 cents per cubic yard was paid for this grading, the railroad furnishing tools and Decauville equipment.

In order to facilitate construction work with standard gauge equipment, a connection track, known locally as spur No. 23, was built from the central division diversion track to touch a point on the Gold Hill line at station 1660. This spur was built in the month of February. All grading for small main line cuts and for shoo-fly tracks was done with Decauville equipment, and this work was rushed in order to take advantage of the dry season and open up the line for further work of steam shovels and pile drivers.

Trestles were driven across all deep valleys. Untreated piles and second-hand decking from former work were used.

The work was so laid out that all available construction plants should be used continuously, and, as a matter of fact, there were no delays waiting for grading nor fortunately for material. Culverts were built where possible by hauling in gravel and cement over standard track; in a number of cases grading would have been delayed by waiting on this method and material was therefore hauled in by wagons and carts, or else rubble masonry culverts were built, with stone picked up near the site. By the end of the fiscal year, the culvert work was 85 per cent complete and the trestles were 95 per cent complete. The first steam shovel started work on Feb. 24, 1911, in the high ridge south of Gamboa. The second steam shovel began work about March 15, in the saddle cut at Paraiso, and the third steam shovel a fortnight later, at the



Typical Cross Section, Quebrada Baja Embankment, Panama R. R.

end of spur 23. Following is the summary work done on the Gold Hill line for the fiscal year:

Total excavation	cu. yds.	696,742
Concrete placed	cu. yds.	7,034.7
Trestle driven	lin. ft.	11,446
Temporary track	lin. ft.	53,639
Clearing done	acres	256.93
Total expenditures to July 1, 1911		$498,610.41

The construction of a permanent telegraph and telephone line was undertaken during the year. This line is built, utilizing 56-lb. steel rails for poles, the same being equipped with four cross-arms, 10 pins to the arm, making a 40-wire line. No. 10 hard-drawn copper wire was used. On June 30 the line from Gatun to Gamboa bridge was 50 per cent complete.

Ballasting operations along the permanent track of the relocated line were continued throughout the year. Chagres river gravel was used for this purpose, secured from the pit operated by the Panama Railroad Co. at Gamboa. About 6 miles of 90-lb. steel was put down in the completed section of the line near Gatun and south of Monte Lirio. This 90-lb. steel was laid in large part on hardwood ties, with patent tie plate and screw spike equipment.

The section of the relocated line from Paraiso Junction to Corozal Junction, a distance of 4.1 miles, was formally turned over to and accepted by the Panama Railroad Co. on Sept. 4, 1910.

It is anticipated that the Gatun-Gamboa section of the relocated line will be ready to turn over to the Panama Railroad Co. for traffic on Feb. 1, 1912, and that the Gold Hill line will similarly be ready for main-line traffic on April 1, 1912.

The Panama R. R. work is under the supervision of Frederick Mears, chief engineer, W. P. Warren, engineer of construction, and M. B. Connelly, superintendent of construction.

Five steel girders ranging from eighty to ninety feet in length and used by the Baltimore & Ohio in Columbus, Ohio, are being encased in concrete as a protection against corrosion. The operation is carried on as follows: the rust is scraped and brushed off, No. 10 Clinton wire cloth is wrapped over the top and bottom flanges and around the columns, the stiffener angles on the girders are punched and three-eighth inch round rods threaded through lengthwise of the bridge on twelve-inch centers and the forms built around the girder in such a way as to give a thickness of concrete of about six inches on all sides. The forms are built one panel length at a time on the ground and hoisted to position. A 1:2:4 mixture is used and poured rather wet. After four or five days the forms are removed and the outside surface floated to a smooth and even finish.

Timber-top culverts for low, flat localities where sediment is likely to fill the opening, are built on the Nashville, Chattanooga & St. Louis Railway with concrete sides and bottoms 8 to 13 in. thick and parapets of separate concrete beams containing a rail reinforcement. When the culvert and channel below it become filled, the parapets and timber top are removed, the walls raised and the top then replaced. This type is usually employed only where the clearance under the tie is limited.

Two additional tracks have been laid by the Illinois Central between Homewood, Ill., and Matteson, five miles. The extension of suburban service to Matteson will be undertaken next spring. Double track improvements have been completed from Hawthorne, Ill., to Parkway on the Freeport division.

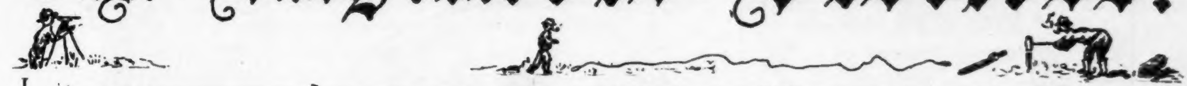
The Minneapolis, St. Paul & Sault Ste. Marie will build 19 additional sidetracks, each a mile long, at the yards at Superior, Wis., to handle the increased traffic upon the completion of its Twin Ports-Twin City line.

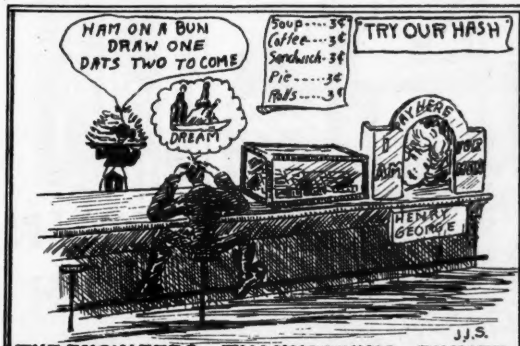
The Mexican government department of communications is said to have received bids for building a line from Balsas, the present terminus of the Cuernavaca division of the National Railways of Mexico, to the port of Zehuatanejo on the Pacific coast in the state of Guerrero. A branch line will also be constructed to Uruapan in the state of Michoacan, where it will make another connection with the National Railways of Mexico. The proposed work involves the construction of about 350 miles of track.

The Oakland & Antioch is stated to have secured all right of way for an extension from Antioch to Sacramento, Cal., and it is expected that contractors will submit figures on the work in the near future.

- NIGHT EDITION -

The Engineer's Distress.





THE ENGINEERS THANKSGIVING DINNER

THE EVENING STORY

BY NORA JANE BIDDY.
DECORATIONS BY GARRISON FISHING.

I

She was tall, yet not too tall, and fair. Her beatiful face was surmounted by a glorious and bewildering mass of golden tresses, so finely spun and artistically arranged that it seemed to rival the work of Mother Nature herself.

Angelina La Fontaine, for that was our heroine's name was seated on Natures mossy couch beneath a spreading chestnut tree. Suddenly and without warning, the villian appeared. A swarthy Low-browed rascal, with a sinister look in his eye. Seeing our beatiful heroine, sitting alone and unprotected, he twisted his face into the semblance of a smile and stepped nimbly before her. "Ha! Ha! he cried, "Well met my little darling can I trouble you for the "Makins." Seeing that

she shrank from him afrighted he grew bolder and sprang upon her. His brutal hand was at her swanlike throat—"I demand the papers" he hoarsely gasped.

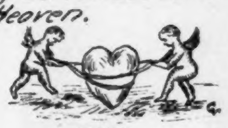
- II -

Meanwhile our hero, was wandering aimlessly down a sylvan glade. His head was bare, his hat being clasped loosely in his left hand. In his right hand, betwixt his index and second finger he held a cigarette, of which he seemed to have lost all consciousness. He was tall and gaunt but in his eye was a look which told of a soul which even an empty stomach could not daunt. Hark! A sound of conflict breaks upon his ear. "A desperate situation" he mutters to himself. "I must away." But unfortunately choosing the wrong path, and stopping long enough only to relight his cigarette, he hurried forward and in due time came upon the harrowing scene which we have described in chapter I.

- III -

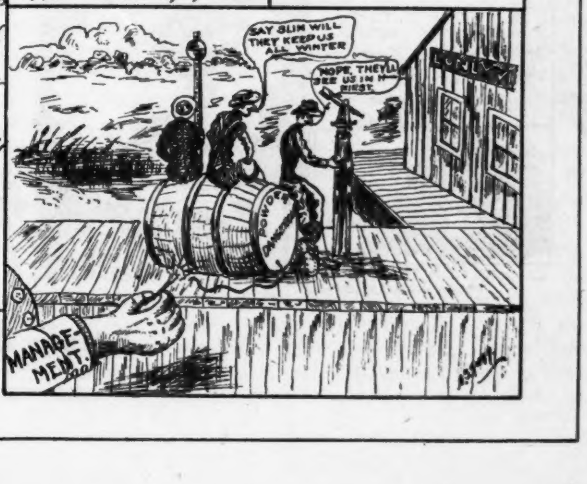
His quick eye discerned immediately that a lady was in distress, and hastily finishing his cigarette he sprang into the melee. Wrapping his lean form about the burly ruffian he crushed him as a constrictor would a rat. Casting his huge victim from him he turned in time to see the fair Angelina swoon and sink to the ground. Remembering that his hat was worn and tattered he cast it aside, lifting the beautiful maiden in his arms he dipped her in the purling brook.

As she opened her glorious eyes and gave him a look of gratitude, he was staggard by her beaty. A still small voice within him whispered "All is off." Blushingly she regained her feet, and snuggled into his protecting arms. "You have saved my life" she softly whispered, "name your reward and it shall be yours". "I want only you" he gasped in an access of emotion,- I am only a poor engineer but — "What"!!!!! she shrieked recoiling, "An Engineer."? And as his shamed look answered her "all is off," "but remember" she cried in a voice she strove to make kind "Though they may hand you a leather medal here below you will surely be rewarded in Heaven.



- FINIS -

RODMAN,- Mother I have come home to die.
MOTHER:-You lie! You have come home to eat.



THE ENGINEER'S DISTRESS.

(More Later)

MOVING A HEAVY BRIDGE SPAN INTO PLACE.

The Des Plaines Valley Ry., a belt line of the Chicago & Northwestern, crosses over the Chicago, Milwaukee & St. Paul right of way at the throat of the Mannheim hump yard on a double-track bridge. This bridge is a structure consisting of a through riveted truss span and through plate girder span on square abutments and a skew pier. The pier was skewed to parallel the tracks of the C., M. & St. P. R. R. The abutments were made square because the type of floor in this bridge is not readily adapted to skew abutments.

The truss span consists of two multiple intersection trusses, 117 ft. 11¼ in. and 131 ft. ½ in. respectively. The floor is of the shallow trough floor type, 2 ft. 4¼ in. from base of rail to low steel. The troughs are placed perpendicular to the axis of the bridge, and are carried by longitudinal girders placed parallel to the trusses and as near the track as the clearance diagram will permit. The longitudinal girders are carried by floor beams at the panel points, which transmit the panel loads to the trusses. This is the type of floor in general use on the Chicago & Northwestern, where extreme shallowness of floor is required in double-track structures.

The girder span consists of two girders 73 ft. 2 in. and 86 ft. 3¼ in. long respectively, and a floor of the same type as that of the truss span. There are no inside longitudinal girders in this span, and no floor beams, the troughs being extended for direct connection to the main girders, making the floor uniform throughout the entire length of span.

The erection of truss spans with this type of floor follows the usual procedure of truss bridge erection up to a certain point—placing the floor beams, truss members and bracing. But before the longitudinal girders or trough sections are placed, it is necessary to do all the riveting of floor beams to trusses, bottom chord splices and web members to gussets up to the level of the tops of the girders. After these girders are in place, no riveting can be done on the inside of that part of the trusses directly opposite them.

In erecting this bridge, it was necessary to maintain the usual vertical clearance of 22 ft. above the surface of the C., M. & St. P. R. R. tracks; also to keep the Des Plaines Valley Ry. track on the temporary bridge open for construction trains.

The first of these conditions was met by erecting the truss span at a temporary elevation 3 ft. 1¼ in. above that of its permanent elevation; this afforded room for the necessary blocking under the chords, without encroaching on the vertical clearance.

To facilitate the construction of the line a temporary pile trestle had been built leading up to the and over the freight tracks of the C., M. & St. P. Above the main line passenger tracks an old through girder span was used, the opening being about 35 ft. This span was supported on bents, each consisting of a double row of piles closely driven.

The borings which were made to determine the nature and bearing value of the subsoil showed the following: Boring "A," 1.0 ft. black soil, 1.0 ft. soft yellow clay, 4.25 ft. hard yellow clay, 2.0 in. yellow clay mixed with blue, 5.5 ft. hard blue clay, 1.0 ft. soft blue clay, 3.5 ft. soft blue clay mixed with fine sand, 1.5 ft. stiff blue clay, 4.75 ft. hard blue clay. Boring "B," 1.2 ft. black soil, 0.8 ft. soft yellow clay, 6.6 ft. hard yellow clay, 5.5 ft. hard blue clay, 3.4 ft. soft blue clay mixed with sand, 2.5 ft. soft blue clay, 3.1 ft. stiff blue clay, and 1.5 ft. hard blue clay. Good hard clay was reached in "A" at 20 ft and in "B" at 23 ft.

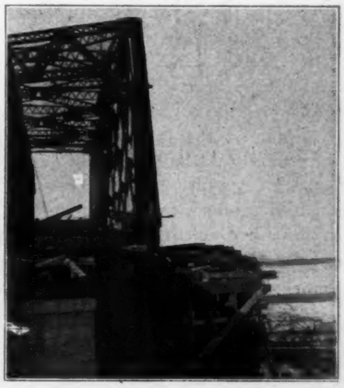
The abutments are of plain concrete, both being alike with bridge seats at the same elevation. The average soil pressure under the abutments is 5,000 lbs., the maximum being 6,700 lbs. per square foot. The average pile pressure is 33,900 lbs., the maximum being 41,700 lbs. Each abutment required 875 cu. yds. of concrete, which was mixed in the following proportions:

First section, to 4 ft. above bottom (footing).........1:3:6
Next section, 23 ft.................................1:3:5
Next section (top), 8 ft.............................1:2:4

The center pier required 543 yds. of concrete, mixed in the same proportions and placed in a manner similar to that in the abutments. Average soil pressure 5,000 lbs., maximum 7,800 lbs. Average pile pressure 36,000 lbs., maximum 52,000 lbs.

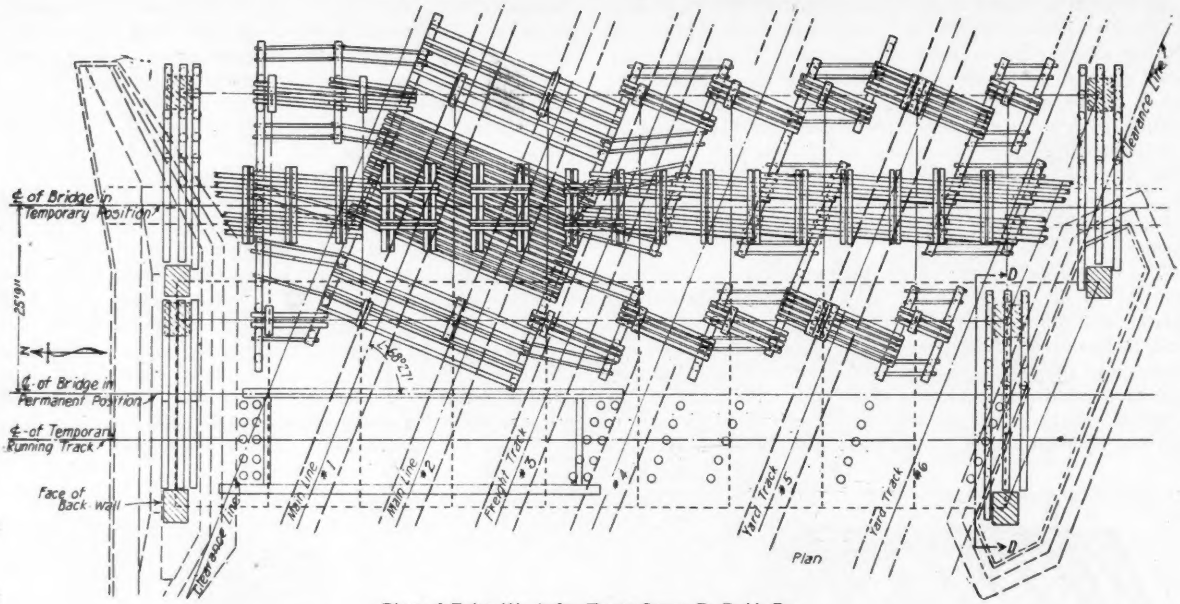
In order to comply with the second limiting condition (mentioned above), the truss span was built up on false work to one side of the center line of track, and then slid into place on skids. This method allowed the use of the temporary track until the span was entirely constructed and ready to simply slide in and take the place of the temporary bridge.

Bridge Over C., M. & St. P. Tracks, Des Plaines Valley Ry.



Incline Down Which Span Moved.

It was difficult to locate the temporary false work so that it would not interfere with traffic on the C., M. & St. P., and after a study of the layout of the Milwaukee tracks it was found that freight movements could be shifted from track 3 to track 5 by using crossovers which were available; track 3 was killed. Track 4 had been laid up to the bridge on either side, but had never been connected or used, and so it was not necessary to clear this track. The arrangement decided upon left the Milwaukee passenger main lines 1 and 2 open, closed freight track 3, and left track 5 open for freight movements.



Plan of False Work for Truss Span, D. P. V. Ry.

A plan of the false work is shown herewith. The bents were nearly all built up, or what are sometimes called "pony bents." A pony bent consists of a frame work of heavy squared timbers, built up on top of a carefully leveled foundation sill which rests on the surface of the ground. No piles or pile driving are necessary in this construction, and all the timber used can be recovered easily and without damage.

The order of work for the truss was given on the plans as follows:

1. Build false work complete as shown.
2. Erect panel point troughs.
3. Place bottom chord in position on panel point troughs.
4. Erect trusses complete.
5. Rivet up bottom chord and rivet bottom chord to webs as far as necessary to clear top of longitudinal girders; swing span.
6. Erect longitudinal girders and intermediate troughs one panel at a time.
7. Rivet up bridge complete.
8. Slide bridge laterally down inclined plane to proper position and lower to bridge seat.

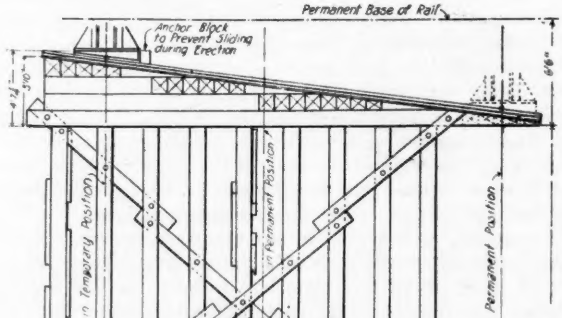
The distance the span had to move was 25 ft. 9 in., and the drop on the incline was 3 ft. 1¼ in. The dead load at each corner was specified to be 150 tons. The work was done entirely by company forces.

The lumber required in the false work is listed below:

76 piles 24 ft. long.
18 piles 22 ft. long.
63 piles 20 ft. long.
21 pieces Douglas fir 8 x 16 in. x 18 ft. 0 in. stringers.
52 pieces Douglas fir 8 x 16 in. x 16 ft. 0 in. stringers, cut 23 to 8 ft. pieces.
50 pieces Douglas fir 8 x 16 in. x 13 ft. 0 in. stringers.
26 pieces Douglas fir 8 x 16 in. x 10 ft. 0 in.
22 pieces Douglas fir 8 x 16 in. x 32 ft. 0 in.
56 pieces pine or fir 12 x 12 in. x 14 ft. 0 in., caps and sills.
94 pieces pine or fir 12 x 12 in. x 16 ft. 0 in., cut 82 to 8 ft.
90 pieces pine or fir 12 x 12 in. x 12 ft. 0 in., cut 48 to 3 ft. pieces, blocking.
4 pieces pine or fir 10 x 12 in. x 10 ft. 0 in.
10 pieces pine or fir 8 x 12 in. x 12 ft. 0 in. blocking, cut 6 to 3 ft. pieces; cut 4 to 6 ft. pieces.
24 pieces pine or fir 6 x 12 in. x 16 ft. 0 in. blocking, cut to 8 ft. 0 in. pieces.
76 pieces pine or fir 4 x 10 in. x 18 ft. 0 in. bracing.
120 pieces pine or fir 4 x 10 in. x 16 ft. 0 in. bracing, cut 15 to 8 ft. 0 in.
50 pieces pine or fir 4 x 10 in. x 14 ft. 0 in. bracing.
54 pieces pine or fir 4 x 10 in. x 12 ft. 0 in. bracing.
10 pieces pine or fir 4 x 10 in. x 10 ft. 0 in. bracing.
130 pieces pine or fir 8 x 8 in. x 10 ft. 0 in. ties, S. I. S.
24 pieces pine or fir 3 x 8 in. x 10 ft. 0 in. lining ties
16 pieces pine 4 x 10. in x 16. ft. 0 in. guard rail.
2 pieces oak 12 x 12 in. x 14 ft. 0 in. blocking, cut to 3 ft. 6 in.
3 pieces oak 10 x 10 in. x 14 ft. 0 in. blocking.
25 pairs of oak wedges as per sketch.

NOTE—Sizes and dimensions of material, except for stringers, may be varied to slight extent. Over-all dimensions to be observed closely. Second-hand material may be used in false work. Stringers may be longer length than called for.

The piles listed above were used in the bents which were located in the embankments.

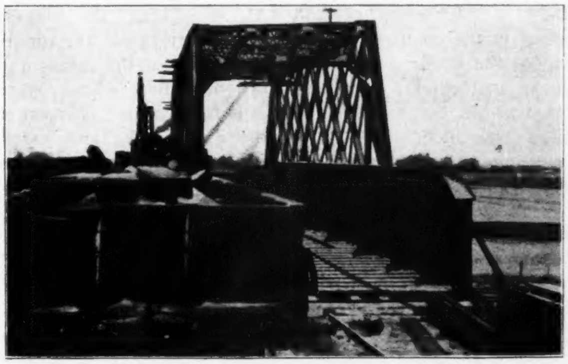


Cross Section of Bent, Showing Incline and Position of Bridge Shoe.

Just before sliding the new span into place the short temporary span was dismembered and loaded on a car piece by piece by a steam derrick, on the overhead track.

The movement of the span was easily accomplished. The end piers of the false work were fitted with four rails on each pier, carried on blocking, and inclined downward toward the permanent position of the bridge. At the upper end of each of these four inclines was placed a sliding base consisting of a steel plate and beveled blocks, which supported the ends of the tracks by their upper shoes. When the span was completely assembled and all riveting completed except some minor work on the floor, the span was moved down the incline to its permanent position.

At the south end, a block and tackle was attached to the bridge and to the end of one of the frame bents, to retard or control the movement of the bridge. The bent, in turn, was firmly anchored to the rails of the dead track on which the bent rested, using a wire cable. The sliding movement at that end of the bridge was easily controlled. On the north end, before starting the bridge down the incline, shores were placed 6 in. or 8 in. in front of each of the sliding bases, to check the movement in case of friction of the rails was not sufficient to hold the bridge against gravity. Jacks were then brought to bear laterally against the upper sides, and the truss moved down the incline until checked by the shores. The shores were then taken out and set forward, the friction on the rails being sufficient to hold the bridge on the incline after it had been brought to rest by the shores. The jacks were applied again, the bridge moving down to the new position aganst the ends of the shores. This operation was repeated until the bridge had been moved to its permanent location, where it was supported on jacks while the sliding bases and inclines were taken out, and the pedestals placed. It was then jacked down into permanent position on the pedestals.



Two Views Showing Position of Span Before Being Moved.

A temporary deck was made by placing 8 x 16 in. timber stringers on top of the panel point troughs, and a track was built on these stringers for immediate use.

The bridge was designed and erected under the supervision of E. C. Carter, chief engineer, Wm. H. Finley, assistant chief engineer, C. S. Hall, engineer of track elevation, and E. L. Mead, assistant engineer, the latter in the field.

CORROSION OF METALS IN A GASEOUS ATMOSPHERE.

The problem of finding a suitable metal for structural purposes, not prohibitive in cost, which will resist corrosion when exposed to locomotive gases, is important to railroads. In order to get first-hand information, the N. Y. C. & H. R. Engineering Department (Mr. Geo. W. Kittredge, Chief Engineer) has made some tests, which, while perhaps crude and limited, still are thought to give some valuable information both on the rate of corrosion of the metals tested and on the comparative rate of corrosion of iron and steel.

Pieces of the metals to be tested, generally in the form of thin sheets, were exposed in two places, one in a tunnel where the atmosphere is very highly charged with locomotive gases and steam, the other the interior of a smoke-jack in an engine-house. In the tunnel exposure the specimens were attached to a wooden frame fastened to one side of the tunnel, in which location they received no blast action from locomotives and it was thought that all would be exposed to equal conditions. In the smoke-jack the plates were hung inside the jack so that the conditions would probably be equal for all plates.

In the first test-series, only few results were obtained. A plate of special iron exposed to the smoke-jack for 189 days corroded at the rate of about 1/32-in. per annum for each surface, or 1/16-in. per annum for a plate with both sides exposed.

In the second series of tests the tunnel test showed the excessive corrosion of the special uncoated iron over that of the others. The amount of this corrosion, compared with that of the similar material in the smoke-jack tests, shows the tunnel conditions to be very much less severe than those of the smoke-jack.

In the smoke-jack one of the special-coated plates, one special iron galvanized plate and one special iron plain plate were exposed. At the first examination, after 65 days' exposure, the special-coated metal showed very much less corrosion than the special iron plates, but this plate was lost before the second examination took place, leaving only the special iron plates, one plain and one galvanized, in this test. The galvanizing was pretty well removed during the first period of exposure (65 days) and thereafter did not assist much (although it did a little). The last examination, after a total exposure of 193 days, showed a loss about the same as that in the first series (189 days' total exposure).

A third and more extensive series of tests has been begun which will include special irons, ordinary wrought-iron, various steels, and some special non-ferric metal. Some of the irons and steels have galvanized coatings and some have lead coatings over the galvanizing.

Some of the results of the one examination so far recorded for this series were unexpected. The galvanized plates show the greatest loss of the ferric metals. The loss of one lead-coated plate was some 75 per cent. greater than that of the other, which might be accounted for by the difference in thickness of the respective lead coatings as indicated by the chemical analyses of the two plates, but as one of these analyses was made upon sheared samples and the other upon drllings too much dependence should not be placed upon this point.—The Canadian Engineer.

PROGRESS IN RAILWAY ELECTRIFICATION.

Among the noteworthy installations of complete electrical equipment and of motors and control that have been made or contracted for by the Westinghouse company during the past year may be mentioned the following:

Boston & Main R. R., Hoosac Tunnel Electrification, 11,000 volts, single phase, complete equipment.

New York, West Chester & Boston R. R., 11,000 volts, single phase. Motors and control.

Rock Island Southern R. R., 11,000 volts, single phase. Motors and control.

Piedmont Traction Co., 1,500 volts, direct-current. Complete station, car and locomotive equipments.

Oakland & Antioch Traction Co., 600-1,200 volts, direct-current. Motors and control.

The Cambridge Subway, 600 volts, direct-current. Motors and control for all cars.

The Boston Elevated Ry., 600 volts, direct-current. Motors and HL control for surface cars.

The Long Island R. R., 600 volts, direct-current. Motors and control equipment for extensions.

Interborough Rapid Transit Co., 600 volts, direct-current. One thousand (1,000) pneumatically operated line switches were furnished for New York subway cars.

Pennsylvania R. R., 600 volts, direct-current, complete equipment for the New York City terminal electrification.

In the following paragraphs is outlined the general trend of progress and some illustrative examples of recent noteworthy installations are given.

Single-Phase System.

The single-phase system has been adopted for three very important projects: The Hoosac Tunnel electrification, the Rock Island and Southern, and the New York, Westchester and Boston installations. The fact that this system was selected after the most exhaustive studies effectively substantiates the claims of its adherents as to the advantages of single-phase operation for certain conditions. Seventeen additional single-phase locomotives have been purchased by the New York, New Haven & Hartford R. R. for operation on its main line. The single-phase operation of the recently electrified Hoosac Tunnel installation is eminently satisfactory.

High Voltage Direct-Current System.

The Piedmont Traction Co. has contracted for complete equipment for its 1,500 volt direct-current system, the details of which are outlined in the following paragraph. About 280 miles of track are to be electrified for passenger and freight service. This is the longest direct-current road in the country and the voltage is the highest ever used for a direct-current railway in the United States.

Interpole Railway Motors.

The demand for interpole railway motors has increased wonderfully during the past year. Many companies that did not at first sufficiently appreciate the advantages of interpole construction and were slow to change over from non-interpole motors are standardizing motors of one of the interpole types. Interpole motors are being specified for nearly all new equipment and can now be furnished for practically all commercial railway applications. The latest addition to the family is the Westinghouse, No. 323, a 32 h. p. motor designed for use on small cars. Interpole motors have not heretofore been made of such small capacity and many companies operating small cars that have not in the past been able to avail themselves of the advantages of interpole construction can now do so.

Forced Ventilation.

The advantages of forced ventilation for railway motors are now being appreciated by operators. Forced motor ventilation has been used for the Westinghouse motors installed on the Long Island R. R. and the Pennsylvania R. R. motor cars and has proven particularly successful. Forced ventilation has frequently been used on Westinghouse locomotives. The New York, New Haven and Hartford, the St. Clair Tunnel, the Spokane and Inland, and others have been so equipped.

Unit Switch Control.

There has been a feeling among operators that unit switch control can be used with economy only for the control of long trains or for heavy high speed cars. That this impression is erroneous is indicated by the order recently placed by the Boston Elevated for fifty equipments of unit switch control for its surface cars. This makes a total of 100 surface car unit switch equipments operated by this company. (See a following paragraph.) Unit switch control is becoming popular not alone because it tends to reduce car maintenance, but because it removes all heavy current carrying parts from car platforms and eliminates all annoying troubles and claims resulting from controller burn-outs.

Hoosac Tunnel Electrification.

The Hoosac Tunnel electrification included the equipment of a total of 12.31 miles of track for electrical operation and five electric locomotives and power house equipment. Of the total track electrified, 50,100 ft. is within the tunnel, which is double-tracked and 4.75 miles long, the longest tunnel in the country. Previous to electrification the tunnel limited the traffic on the division because of the steam and smoke incidental to steam operation. Block signals were not feasible because they could not be seen. Passenger traffic was inconvenienced by the dirt, smoke and gases. Since electrification the air in the tunnel is always pure and clean.

A Westinghouse electric locomotive hauls through every train and its steam locomotive with banked fires. Block signals are being installed and the capacity of the tunnel will be increased over 100 per cent. The Westinghouse Company furnished the entire equipment including all control apparatus, station equipment and the 11,000 volt overhead line material. Six locomotives have been in service since the latter part of May, each having a rating of approximately 1,500 h. p. Half of these are geared for a speed of 30 miles per hour for hauling heavy freight trains. The others are geared for 50 miles per hour and are used for handling the passenger service.

Rock Island & Southern Railway.

The Rock Island Southern commenced operating its 11,000 volt single-phase road early in the year and the equipment has given complete satisfaction. The road is 49.7 miles long and the passenger cars are each equipped with four No. 132-C motors, rated at 100 h. p., and with unit switch control. One express is equipped with four No. 156 motors and unit switch control and one freight car is equipped with four No. 156 motors and unit switch control.

New York, West Chester & Boston Ry.

The New York, West Chester & Boston, a subsidiary of the New York, New Haven & Hartford, is also being electrified with the single-phase system at 11,000 volts. The equipments will be used for high speed passenger service with multiple unit cars and will be interchangeable with those on the New Haven line, but will operate on alternating-current only. This road will start from 180th street, New York City, and terminate at White Plains, fifteen miles distant. A branch two miles long leaves the main line five miles from 180th street and extends to New Rochelle. Energy will be delivered to the cars at 11,000 volts, 25 cycles, and the equipment includes 30 motor cars each propelled by two Westinghouse No. 409-B motors with multiple unit control, and one 80 ton switching locomotive equipped with quadruple No. 410 motors.

New York, New Haven & Hartford R. R.

The New York, New Haven & Hartford has been extend-

ing its electrified zone and has purchased seventeen additional Westinghouse single-phase locomotives with a view of establishing the best class of service. This order, coming in the wake of the initial orders, constitutes further and conclusive evidence as to the reliability of Westinghouse single-phase apparatus. The latest single-phase locomotive ordered by the New Haven Railroad is equipped with four driving axles, but has eight motors, two motors geared to a quill surrounding each axle. This equipment which at first appears more complicated, is in reality lighter and cheaper than a locomotive of the same capacity having four motors of the same total capacity. This type permits the use of small motors for locomotives of large capacity and the matter of repairs is greatly simplified. Each of the small motors has practically one-half the number of brushes, brush-holders, and armature field coils, etc., as has one large motor, so that there is the same total number of these parts on the locomotive as on one equipped with large motors. Both motor pinions drive the same gear which permits the use of only one gear on the quill, while the large motor requires twin gears. It is believed that this type of locomotive marks a decided advance in the art of building electric locomotives.

The method of controlling the speed of electric railway motors by varying the strength of the field has been developed to a thoroughly commercial basis by the Westinghouse Company. The speed of the passenger locomotives on the New York, New Haven & Hartford Railroad, when operating on direct-current, is controlled by the varying strength of the motor fields. This system was so eminently successful, having been operated about four years, that the same plan was adopted for the Pennsylvania Railroad locomotives for its New York City Terminal.

Pennsylvania Railroad Electrfication.

These, the most powerful motors in existence, haul all the trains from Manhattan Transfer near Newark, New Jersey, into the new station in the heart of New York City. The use of field control for speed regulation on these locomotives enables them to run when necessary at very high speeds and at the same time to start the heavy limited trains and to operate them over certain sections at low speeds with minimum power consumption. Each locomotive weighs, complete, 157 tons and exerts a maximum draw bar pull of 79,200 pounds. The normal speed with full train is 66 miles per hour. The operation of the Pennsylvania locomotive has been conspicuous for its very successful record.

On the Pennsylvania locomotives the motors are connected, first, with full field series; second, normal field series; third, first parallel; fourth, normal field parallel. This method gives four highly efficient operating speeds. The full field gives an enormous tractive effort at slow speeds and the normal field permits them to haul comparatively heavy loads, at high speeds, thus enabling the motors to efficiently operate over a much wider range of speed than would be possible without the field control. This whole Pennsylvania installation has been remarkably successful. The commutation of the motors is perfect, irrespective of field strength. Their operation demonstrates conclusively the great flexibility of modern interpole railway motors, and their adaptability to conditions which could not be satisfied by non-interpole motors.

Pacific Electric Railway.

The Pacific Electric operates a network of 600 volt, ballasted and signalled, roads radiating from the city of Los Angeles, California. Los Angeles, with a population of but 320,000, operates more interurban trains per day than the nine most important middle western cities with an aggregate population of 4,000,000. The departures per day from Los Angeles recently amount to 1,882 over 29 routes. The cars must operate at low speeds in the cities and at high speeds in the country, so that the current consumption at slow speeds will not be excessive; with the gear ratios necessary for high speed limited service, Westinghouse field control has been applied. Westinghouse field control is destined to be the solution for interurban problems, in that it permits, with moderate gear ratios, high interurban speeds and slow city speeds.

Piedmont Traction Company.

The Piedmont Traction Company and the Greenville, Spartanburg & Anderson Railway Company have contracted for equipment using 1,500-volt direct-current apparatus. These roads form two branches of a new railway system in North and South Carolina. This is the largest electrification project ever undertaken, as the property consists of about 280 miles of track and the equipment will include both cars and locomotives, the latter to be used for freight service.

Electric-pneumatic control—which is peculiarly adapted for use on high tension direct-current voltages—will be used, and while the motors will be of standard interpole construction, the matter of commutation has been given special attention. The control for passenger cars, express cars, and locomotives will be standard HL unit switch type, but a special feature is in the dynamotor compressor. This form of compressor is designed for use in connection with the air-brake outfit. The air compressor is driven by a continuously running dynamotor instead of the usual intermittently running compressor motor. The dynamotor drives the compressor by means of a friction clutch of the standard automobile type, which is automatically cut in or out when the air reaches a certain pressure limit. The dynamotor ordinarily furnishes power for the control and lights, but in this case it serves also to operate the compressor, making unnecessary the use of a separate motor.

Boston Elevated Railway.

The Boston Elevated is admittedly one of the most successful and economically administered city traction properties in the country. It was one of the first concerns to appreciate the advantages and economies of interpole motors and unit switch control and to adopt them. Fifty cars equipped with No. 306 motors and HL control gave such extraordinary satisfaction that fifty additional duplicate equipments were ordered. The cars on which these equipments are to be used, although they operate on the surface, connect with the Boston Elevated Lines. One of the factors that influenced the company to adopt HL control is that, with it, all heavy-current carrying parts are mounted under the car bodies away from the platforms. Hence there cannot be platform controller burn outs with their attendant delays in service, destruction of equipment and accidents to passengers that result in expensive claims. With HL control the contactors are forced together with air pressure and apart by powerful springs. Positive, reliable making and breaking of the contacts is assured regardless of the line voltage.

Cambria Subway.

The Cambria Subway in Boston is a new and notable rapid transit project. This subway, which is almost completed, will reduce the schedule between Harvard Square, Cambridge, and Park Street to eight minutes. There are but two stations between terminals, one is in Central and the other in Kendall Square. The subway will cost $8,000,000. The electrical energy will be supplied to the cars at 600 volts direct-current. All of the car equipment, consisting of outfits of No. 300 interpole motors and AL unit switch control, will be furnished by the Westinghouse Electric & Manufacturing Company.

Long Island Railroad Electrification.

The Long Island is doubtless one of the most progressive and one of the most representative electrified steam railroads in the country. Its equipment has now been in service long enough to prove its adaptability. It operates at 600 volts, direct-current. The trains operate from the Pennsylvania Station, New York, through the East River Tunnels, and from the Flatbush Avenue Terminal, through the Atlantic

Avenue Tunnels, to the suburban territory and resorts on Long Island. Nearly 200 miles of track have been electrified since 1903, in which year electrical operation was initially adopted. The direct-current, third rail system was adopted to permit interchange of cars with the subway and elevated lines of New York City.

A feature of the latter electrical equipment of the Long Island Railroad cars is the application of forced ventilation for the motors used on the high speed trains. It was desirable to obtain the highest possible outputs from the motors and maximum output was secured through the use of cooling air which is directed by a motor-driven fan into the motor frames. Forced ventilation is often advantageous and has frequently been used on electric locomotives by the Westinghouse Company with uniformly successful results, but it is only recently that operators are appreciating its advantages as applied to motor car applications. The Long Island car equipments consist of two 225 h. p. motors and automatic unit switch control.

Oakland and Antioch R. R.

The Oakland and Antioch, of California, has recently purchased quadruple 75 h. p. 600-1,200 volt motors, 115 h. p., 600-1,200 volt quadruple motors and one 47-ton locomotive provided with quadruple 120 h. p. motors. All are to be equipped with double and HL control. The 75 h. p., or No. 321, motors and the 115 h. p., or No. 322, motors are to be mounted on cars of the same weight. The car bodies for these will weigh approximately 20 tons and the trucks about 11 tons.

These equipments, as well as the locomotive, will operate over the lines of the San Francisco, Oakland & San Jose R. R. from the end of the Key Route to Claremont, a distance of about seven miles. At Claremont, the Antioch and Oakland cars will be uncoupled and will be operated individually; each car hauling one trailer over the lines of the Oakland & Antioch R. R. Company. On the line from the Key Route Pier to Claremont, the voltage will be 500. From Claremont to Walnut Creek, a distance of about five miles, the voltage will be 1,200, direct current. The HL control equipments will be designed to operate the motors on both 600 and 1,200 volts. On 600 volts, the motors will be in full parallel and on 1,200 volts, two will be in series and two pairs in parallel.

On the Oakland & Antioch line between Claremont and Walnut Creek, there is 4,000 or 5,000 feet of 4% grade. Later new track will be laid which will increase the distance but will reduce this grade to 2%. The road passes through a tunnel about four miles long with a 2% grade, and from this point the track is practically level to Walnut Creek.

Line Switches for Manhattan Elevated.

On systems where many cars or trains, requiring considerable power, operate in a section served by one feeder from a high capacity station, considerable difficulty has been experienced at times when a short circuit or flash over occurred on any car in a train. At such times the voltage on the entire section drops for an instant to a very low value (due to the heavy draught of current), until the fuse or circuit breaker on the car in trouble opens and stops the heavy current flow. When the heavy current flow is suddenly ruptured by the circuit breaker or fuse on the car in trouble, an abnormally high voltage is instantaneously impressed across all of the motors in the section. The abnormal voltage is due to the "inductive kick" caused by suddenly rupturing the heavy current. This high voltage frequently causes many of the motors on the tram to flash over. The original difficulty is aggravated and delays ensue.

By installing a Westinghouse line switch on each car, the possibility of trouble due to this condition is reduced to a minimum. When the voltage drops, because of the heavy current, the line switch relay acts, opens the switch, and when the surge occurs there is no circuit through the motors. Hence the only car affected is the one in which the original trouble developed. The line switch, which is in effect a very powerful circuit breaker with a no voltage and an overload release, is readily closed by the motorman by the operation of an auxiliary switch.

The Manhattan Elevated has purchased 1,000 of these electro-pneumatic line switches for its cars which are operated with type M General Electric control, and 80 complete Westinghouse HL control and interpole motors.

TRACK ELEVATION, PENNSYLVANIA R. R.

The Pennsylvania R. R. recently put in service at Bristol, Pa., its latest development in the rapid progress which is being made in the elimination of grade crossings, reduction of grades and curves, and general improvement of facilities for handling passengers, freight and baggage along its lines.

Ten grade crossings were abolished by this improvement which cost approximately $1,012,000. The maximum degree of curvature is reduced from one degree and forty minutes to forty-five minutes, and the number of degrees of curvature is made less by fifty-six. The new line is a quarter of a mile shorter than the one which it supplants.

Bridges have been erected over seven streets—four of solid reinforced concrete floor construction supported by steel, and three of reinforced concrete slabs. A deck girder bridge with a solid reinforced concrete floor was built at the crossing over the Delaware and Raritan canal, and two streams are spanned by arches. In all 23,061 cu. yds. of concrete masonry were placed, 524,364 lbs. of reinforcing steel, and 2,131,380 lbs. of steel superstructure were used.

The embankment, which contains about 780,000 cu. yds., is finished to the Pennsylvania R. R. standard, so designed as to afford the best possible surface drainage.

A new passenger station has been built on the south side of the tracks at Beaver Dam Road, Garden and Prospect streets. It is on the street level, and covered stairways connect it with the track platforms. The main building is constructed of stone from local quarries, ornamented with Indiana limestone. The roof is slated and the driveway at the front is protected by a porte-cochere.

This new change of line at Bristol is of four tracks, each being equipped with electro automatic block signals of the latest type. In each track there is a water trough which enables trains to take water without stopping.

At an estimated cost of $2,975,000, the Pennsylvania Lines West are eliminating grade crossings at Cleveland, O. Two million and sixty-three thousand dollars of this expenditure will be met by the railroad company.

Since 1900 the Pennsylvania has avoided grade crossings in all new construction work and has been doing away with those already in existence as rapidly as possible. Many millions have been spent in this work with the result that 673 grade crossings were eliminated from the Lines East between Jan. 1, 1900, and Sept. 1, 1909.

Three hundred and eighty-five of these were on the lines of heaviest traffic between New York and Washington, and Philadelphia and Pittsburgh. Their elimination involved the elevation or depression of tracks in Jersey City, Newark Elizabeth, Trenton, Philadelphia, Chester, Wilmington, Baltimore and Washington. The remaining grade crossings on these lines are dispersed over 574 miles of road, and are, with few exceptions, at points where the street traffic is light.

The track elevation work in progress at Cleveland covers a distance of about two and one-eighth miles. In this territory there are now sixteen streets intersecting the Cleveland and Pittsburgh R. R. tracks at grade. The abolition of all these crossings will be effected; four of them by closing the streets, and the other twelve by raising the tracks and depressing the streets. Solid floor steel bridges, supported by masonry abutments on the street lines, and steel columns at the curb lines, will be used.

In connection with this the passenger and freight facilities at Euclid avenue will be re-arranged. The passenger station will be moved slightly, but will remain on the present level; that is, a little above the street. Platforms with shelter sheds will be erected at the new track level, and will be connected with the station by a subway and stairs.

GRAND RAPIDS ROUNDHOUSE, P. M. R. R.

A forty-three stall roundhouse for the Pere Marquette at Grand Rapids, Mich, has just been completed by the contractor, Houser-Owen-Ames Co. The job was started on May 1. The diameter of the house is 386 feet and it is served by an 85-foot electric table made by the King Bridge Co. The building is built of reinforced concrete and one of the illustrations shows the job after it had been under way about six weeks. Two tracks were run into the building, separated enough to allow room between them for concrete mixer, hoisting engine, tower, etc., and so that cement cars could be placed on one side of the mixer and gravel cars on the other. It was necessary to have considerable track room as nearly a car of cement and about four or five cars of gravel were used per day. The gravel was unloaded with a William's single line one yard clam shell dumping directly from the cars into the storage bin back of the mixer, and there was no trouble in handling the gravel faster than it could be used.

The concrete was all hoisted in a concrete bucket and dumped into a bin built at the top of the tower. From this point it was distributed by means of an open sheet-iron trough to the engine pit forms. The only closed pipe used was the last thirty feet or so which was attached to the end of the trough with a sort of swivel joint which, together with telescopic action with the end sections of pipes, allowed any point in the pits to be reached without trouble. About 125 to 150 yards per day was the average throughout the larger part of the job, which consisted of putting in a total of about 8,000 yards of concrete.

The building contains about half a million brick and about six hundred thousand feet of lumber, there being altogether in the neighborhood of six hundred cars of building material used on the job, aside from some twenty thousand yards of gravel filling inside the building between pits to bring the site which was quite low up to the proper level.

The photograph taken at the entrance to the house shows a small addition on the right of the tracks which is for tool room, toilet and locker rooms and roundhouse foreman's office. Previous to the construction of this roundhouse the Pere Marquette was using a 24-stall house with an electric transfer table. This is now being remodeled for an addition to the shops by taking off a large part of the roof, and putting in steel columns and trusses.

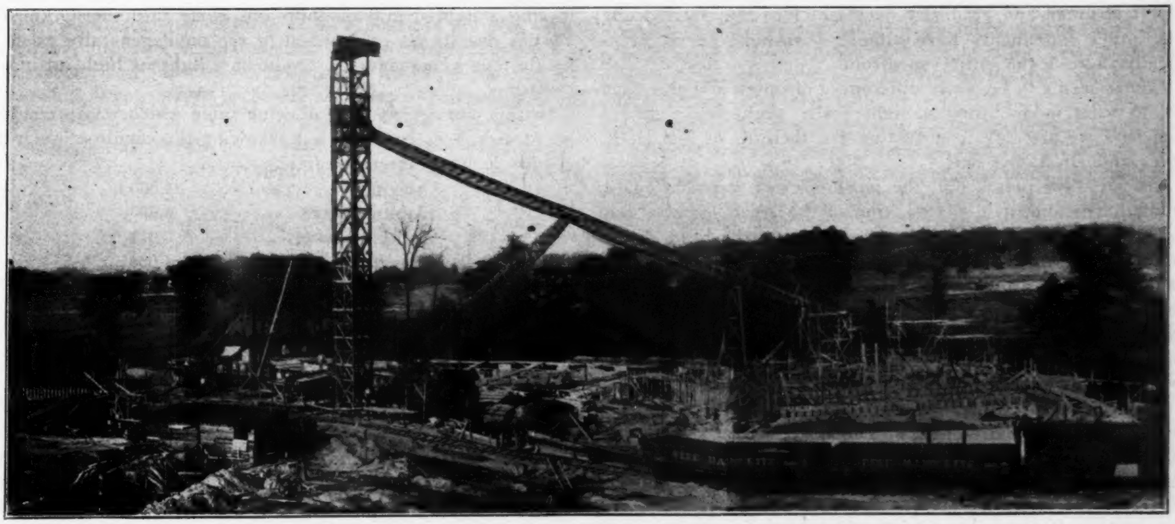
Entrance to Roundhouse, Pere Marquette R. R., Grand Rapids, Mich.

THE LIGHT FOR SAFETY.

By Frank R. Fortune.

Natural light has always been the criterion of that which is most desirable to obtain by artificial lighting. The broad problem in artificial lighting is how to obtain, with the comparative feeble flux of light we have at our command from artificial sources, as close an approach as possible to the character of lighting obtained from the enormous flux of daylight. With the well-known limitations of artificial light, it would, at first sight, appear impossible to reproduce in effect the conditions which obtain in daylight illumination.

The development of the science of illuminating engineering has, however, demonstrated that step by step we are changing our methods of artificial lighting and approaching more



Construction View of Grand Rapids Roundhouse, Pere Marquette R. R.

nearly the ideal conditions. The handicap of artificial light is not nearly so great as would appear.

The ability of the eye to adjust itself to a very low-working intensity of illumination makes it possible to simulate daylight conditions in the design of the artificial lighting of interiors. While we recognize this possibility, we realize that before the completion of an ideal design, there remains to be performed a mass of experimental work, investigation and research, involving a close analysis of conditions of illumination of which we have practically no data at present, and in general, a complete study of the problem from the physical, physiological and psychological standpoints.

Up to the present time, lighting by artificial sources has, for the most part, been carried on by illumination from substantially point sources. These are the sources with which we have to do for the most part at present.

In studying the principles underlying the application of artificial light to the illumination of interiors, it would be well to consider several subjects; first, flux of light; second, diffusion and direction of light; third, quality or color of light; and these studies may be defined in several items such as

Character of the illuminant,
Intensity of illumination,
System of illumination, etc., etc.

Let us first look at the spectrum, running from red through to violet. Considering light as a physiological effect, it will be noted that with some of the colors of the spectrum one can see more rapidly than by others. The quality is known as luminosity. The relative luminosities of the colors of the spectrum are about as follows:

Ultra-red	0
Red	12
Yellow	280
Green	1000
Violet	16
Ultra-violet	0

Therefore, it will be readily seen that the colors in which the acuity of vision is greatest are yellow and green. Let us refer to the illustration, showing the physiological effect of the spectrum, and which is the average, i. e., a medium intensity between the high and low intensities. This you will note shows a larger number of luminosities in the green than any other color.

The curve of the spectrum of the Cooper Hewitt lamp shows a very thin band of red and orange to beyond the edge of the yellow and then takes an abrupt rise in the yellow and green and gradually decreases into the violet, while the other illuminants have almost a straight curve, practically, across the entire spectrum.

There seems to be many differences of opinion at this time as to what monochromatic light really ought to be, and I am sure we are safe in accepting the theories of Dr. H. E. Ives and Dr. Louis Bell.

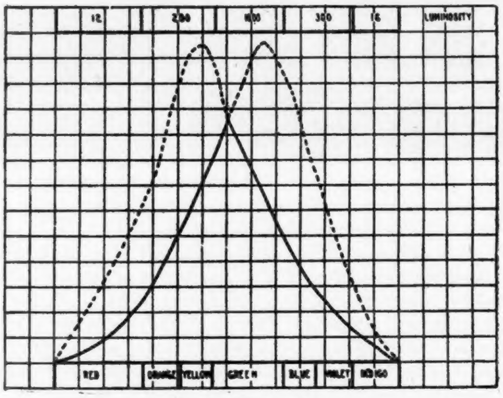
As Dr. Ives points out, the most efficient monochromatic radiation is almost in the position of the green mercury line which furnishes a very large percentage of the light of the mercury arc. For light of this wave length, Dr. Ives figures an efficiency of about 65 spherical candles per watt. The highest possible efficiency of white light in a continuous spectrum he reckons at 26 spherical candles per watt, so that the monochromatic source has a prodigious theoretical advantage and practically a considerable additional gain.

A peculiarity of the mercury light is that by taking two units, both of the same intensity, one, for instance, yellow, as the flaming carbon arc and the bluish green light as the mercury lamp, by going near the lamps, the yellow seems to increase more rapidly in intensity than the green and for a very short distance the flame appears glaringly bright, while the latter disappears and shows nowhere near the same intensity, when going farther and farther away from the two lamps; and the yellow light seems to fade out more rapidly than the bluish green and has practically disappeared while the bluish green is still markedly visible. The mercury lamp, therefore, can be seen from a distance, while a flaming arc is practically invisible.

It would therefore seem that the light of the Cooper Hewitt lamp is more penetrating than a light of a continuous spectrum. This is particularly true in mills and shops where smoke and dirt arises from the floor.

It would seem that conservation of sight should be one of the most important lines to work on in the broad subject of safety. Let us sum up now the different thoughts that come to us, first, looking at a spectrum of various illuminants, we would say that the mercury lamp has a maximum color in the yellow green, which we have shown has the greatest luminosity or seeing value.

Also on account of the length of the light giving area of the mercury lamp, shadows are eliminated more than with



Light For Safety.

other forms of illumination. You realize, however, that for special illumination, it is necessary to have sufficient direct light to mark the edge of the objects by their shadows and thereby improve the distinction, but at the same time, there must be sufficient diffused light to see clearly in the shadows, that is to say a proper proportion of direct and diffused light is necessary. Sharp shadows, however, are dangerous.

One of the most dangerous things in working around a mill or shop at night is going in and out of a well-lighted building. One usually finds a momentary blindness after leaving a lighted mill or shop and going into the darkness. This is due to the contraction of the pupil generally caused by the eye being under a strain in a light of high intrinsic brilliancy.

In this connection the following table which was prepared by Messrs. Ives and Luckiesh, showing the candle power per square inch, is interesting:

Carbon Arc, crater,	84,000
Flaming Arc,	5,000
Nernst Glower,	3,010
Tungsten—1.25,w.p.c.,	1,060
Carbon—3.5 w.p.c.,	400
Welsbach Mantle,	400
Cooper Hewitt,	14.9
Kerosene Flame,	9

It is a very interesting experiment to take two mills or shops with comparatively the same intensity of illumination, one lighted with Cooper Hewitt Lamps and the other with arcs or flaming arcs, and go from the Cooper Hewitt room out into the dark and perceive how readily and easily you can see almost instantly; while going from the other mill or shop, the same being lighted with arcs or flaming arcs, it is necessary as soon as one steps into the dark to stop and allow the eye to readjust itself for the new conditions. There

is a blindness which seems to come over one. This is an important item which also should appeal to the "safety side" of industrial illumination.

And in closing, I wish to bring out very forcibly the subject of glare. At a recent meeting of the London Illuminating Engineering Society, the best definition for glare seemed, to be "Light of Place." I believe that glare and high intrinsic brilliancy go hand in hand and should be dealt with as a dangerous foe to safety. I do not think that I can impress too strongly the advisability of adopting a system of illumination that has a low intrinsic brilliancy and has an absence, to the greatest possible degree, of glare.

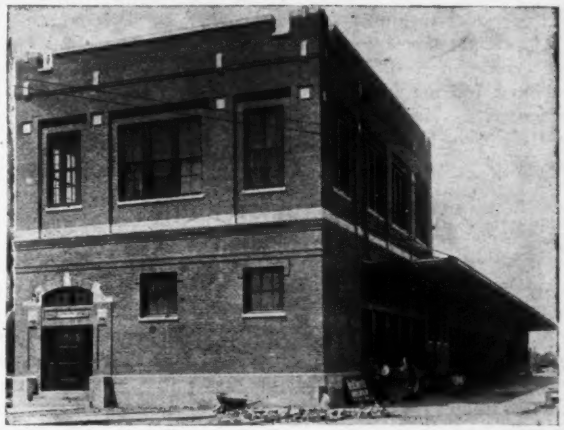
FREIGHT HOUSE AT COUNCIL BLUFFS, C., R. I. & P. RY.

The C., R. I. & P. had a fire that wiped out its Council Bluffs frame freight house, which has since been rebuilt practically fireproof in about the same location, with only a few track changes, to provide more car facilities. The building is 40 by 257 ft., one and two story (second story freight office), and a small basement for the heating plant under the two-story portion. The second story is 40 by 65 ft., and is very well lighted by large windows reaching to within a few inches of the ceiling. It contains a pubilc lobby, cashier's office, private office for agent, vault, general office and toilet rooms. The general office contains record storage shelving running to the ceiling, with bicycle step ladders between. The record room is separated from the general office by a counter only, over which clerks handle their files supplied by the file clerk who is in charge of records.

The first floor contains the stair hallway, and a hold-over room, which is supplied with heat so that perishable freight may be handled in winter, toilet room, foreman's office and four check offices and four four-ton scales, size 4 ft. 6 ins. by 6 ft. 10 ins. The freight room is divided into two sections by brick fire walls with Fire Underwriters' doors; these come under the end wall of the second floor section.

The building cost $40,000 complete, including plumbing, heating, electric lights, scales, filing cases, etc. It is built of brick walls on concrete foundations. The frame work is of cast iron posts and steel beams and girders incased in concrete. The floors are of concrete covered with maple. The roof and second floor is of reinforced concrete.

The foundations are all of concrete, the contractor furnished the sand, crushed stone and water for the concrete, and the company furnished the cement. With this arrangement there is no incentive for a contractor to skimp on the cement, and the result is usually a better class of concrete. The sand used was required to be at least 60 per cent coarse grains, and to contain less than 5 per cent of silt loam or other foreign substances. The stone for plain concrete was crushed limestone of such size that the largest could be enclosed in a 1¼-in. cube, and not more than 1-10 by volume could pass through a ¼-in. sieve. The broken stone for reinforced concrete was crushed limestone of such size that the largest could be contained in a ¾-in. cube, and not more than 1-10 by volume could pass through a ¼-in. sieve. The forms used were of 2-in. matched and dressed lumber, carefully built and braced. Floors and exposed concrete surfaces were finished smooth with a wearing surface of 1-in. of cement and sand, in the proportion of 1 to 1; finish being applied and troweled level and smooth before the concrete underneath had set.



Freight Station, Council Bluffs, Ia., C., R. I. & P. Ry.

The concrete walls, and the basement floor were waterproofed by the McCormick Waterproof Portland Cement Co.'s compound, a white powder of which 10½ lbs. were used for each barrel of Portland cement; this compound is mixed dry with the cement in a pebble mixing machine furnished by the manufacturers. The concrete basement floor was made in the proportions 1-2-4, with a top dressing of 1 to 1.

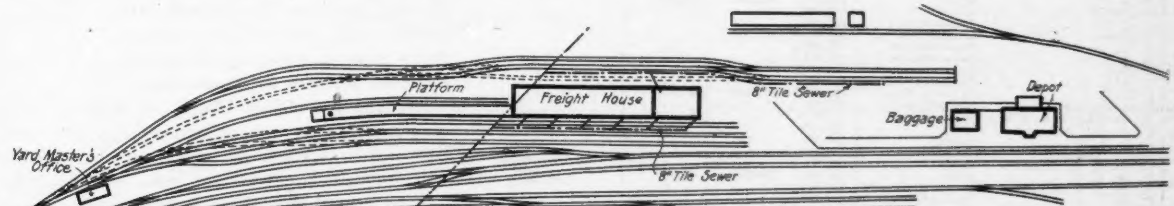
The forms for reinforced concrete floor slabs were made as nearly water tight as possible, using surface lumber that had received a light coat of linseed oil. The concrete was put in very wet, and thoroughly spaded around beam flanges and reinforcing rods. The reinforcing rods were wired in place.

Concrete was left to dry for six days before removing the forms, in the meantime wetting the concrete if necessary to prevent too rapid drying.

The walls of the freight building are of first-class hard burned building brick, using a 1 to 3 mixture of Portland cement mortar and sand. Face brick are all extra quality vitrified pressed brick.

The roof of the building is of concrete, finished with a 1-in. coat similar to the floors; the whole being graded to carry water to gutter or outlet. On top of the concrete a Barrett specification roof was laid.

The Chicago, Rock Island & Pacific requires the contractor to repair and make good at his own expense, all defects which may appear in the work within one year after its final accept-



Location Plan, C., R. I. & P. Ry. Freight House at Council Bluffs, Ia.

ance, arising, in the judgment of the chief engineer, from defective workmanship or material.

The freight house was designed and constructed under the supervision of J. B. Berry, chief engineer, to whom we are indebted for the information and illustrations herein contained; A. T. Hawk, of the C., R. I. & P. was the architect, and the Geo. B. Swift Company, of Chicago, was the contractor.

ROLLING LOADS ON BRIDGES.*

J. E. Greiner, Consulting Engineer.

Coincident with the introduction of a particularly heavy type of locomotive is always the question as to whether bridges are being constructed of sufficient strength to safely carry this heavy engine and its possible future development. This same question has been cropping out time and time again during the past thirty years or more, and the answer has heretofore frequently been evidenced by the construction of somewhat stronger bridges.

During each successive revision of the specifications it was believed that the practical limits of locomotive weights and car capacities had been fully anticipated, but the fallacy of this belief has been demonstrated so frequently that now few engineers feel inclined to assert, with any degree of confidence, at what point or at what time this development will have reached its limit.

Since 1835, about the time the first bridge was built for carrying trains, locomotives have developed from the miniature 4-wheel grasshopper weighing less than 22,000 lbs. to the enormous 24-wheel articulated type weighing 616,000 lbs.

About 20 years ago the heaviest engine in service on the Baltimore & Ohio was a Consolidation weighing about 134,000 lbs.; at the present time this road has articulated engines weighing 463,000 lbs. Similar increases have taken place quite generally on other roads until the heaviest engine of each type have now reached the weights given in Table 1.

This table also gives the weight and wheel base of double-header engines with their tenders for all types excepting the articulated, where a single engine with tender is used in comparison. Attention is called to the fact that the wheel bases of all double-header engines, excepting the electric types, are considerably larger than Cooper's E series generally used for bridge designs. The articulated types, being single, have shorter wheel bases than the double-headers of other types.

The heaviest locomotives in actual service on thirty-six American railways are given in Table 2, which table also indicates contemplated increases.

The increase from the 22,000-lb. grasshopper used on the Baltimore & Ohio in 1835 to the articulated type weighing 463,000 lbs. has been rapid and remarkable, showing an increase from 133,000 lbs. in 1890 to 463,000 lbs. in 1911, which is about 248 per cent in the past 21 years. There are much heavier engines in use on other roads.

The maximum axle load in 1835 was 5,500 lbs., while at present it has gone beyond 65,000 lbs., with limit not yet reached.

Bridge Specification Requirements.

The specification loading for bridge design as now in use by the various railroads is given in Table 3, which table also gives the impact allowances and permissible unit-stresses. The simplest manner of comparing these various specified loadings, including their different impacts and unit-stresses, is by reducing them to an equivalent loading on the basis of the American Railway Engineering Association Specifications. These specifications provide for a consolidation type of engine known as Cooper's E-40, E-50, E-60 series, depending upon whether the weight on each driving axle is forty, fifty or sixty thousand pounds. The equivalent loading given in the sixth column of Table 3, therefore, means that the specified loading, impacts and unit-stresses, as adopted by the various railways, are practically equivalent in their effects on bridges to the Cooper's E series loading noted, when used in connection with the American Railway Engineering Association Specifications.

It will be observed by reference to table 3, column 6, that eleven roads are building bridges for a strength practically equal to E-60 bridges, four for E-57, seven for E-55, one for E-53, eleven for E-50, four for loads under E-50, and one for loads over E-60. Of those roads which are now designing bridges for E-50 or under, two propose the change to E-60 and three to loading in excess of E-50 in the near future.

It may be reasonably assumed that the specifications in force, or the proposed changes, represent the views of the engineering department of the various railways relative to the sufficiency of the present requirements for meeting future conditions, and on this assumption.

One road considers E-65 insufficient,
Thirteen roads consider E-60 sufficient,
Fifteen roads consider E-55 sufficient,
Ten roads consider E-50 sufficient.

In order to determine the relative effects, on bridges, of the various heaviest types of engines in service and the usual specification E-50 and E-60 class, the maximum shearing and bending stresses produced by each type were calculated for spans ranging 10 ft. to 100 ft., all locomotives, excepting the articulated types, being considered as running double-headers drawing a train of 5,000 lbs. per foot of track. On the assumption that the maximum stress produced by E-50 class is represented by unity, the proportional maximum stress produced by the various locomotives on bridges under 100 ft. is given in

*From a bulletin of the Railway Engineering Association.

TABLE 1—HEAVIEST LOCOMOTIVES OF EACH TYPE.

Type.	Engine Alone.		*Double-Header.		
	Weight, Lbs.	Wheel Base, Ft.	Weight, Lbs.	Wheel Base, Ft.	Weight, Per Ft.
Atlantic	214,800	30.79	728,400	127.76	5,700
Prairie	244,700	34.25	807,500	132.92	6,070
Consolidation	260,100	26.50	860,400	131.81	6,520
12 Wheel	262,000	27.08	817,400	130.15	6,280
Decapod	267,000	29.83	802,000	127.00	6,320
Pacific	270,000	35.20	865,400	142.48	6,070
Mikado	305,000	35.00	960,000	150.00	6,400
12 Wheel Articulated	334,500	30.66	473,800	64.56	7,340
10 Coupled	361,000	43.50	1,074,000	161.00	6,670
20 Wheel Articulated	478,000	59.80	703,600	99.70	7,060
16 Wheel Articulated	493,000	40.17	588,000	82.58	7,130
24 Wheel Articulated	616,000	65.92	841,600	105.82	7,950
12 Wheel Electric	300,400	38.50	600,800	86.50	6,950
16 Wheel Electric	320,000	44.22	640,000	102.84	6,220
†Cooper's E-50	225,000	23.00	710,000	104.00	6,830
†Cooper's E-60	270,000	23.00	852,000	104.00	8,190

*Weight and wheel base for articulated engines are given for one engine and tender.
†Cooper's E-50 and E-60 typical consolidation engines are given for comparison.

TABLE 2—HEAVIEST LOCOMOTIVES IN ACTUAL SERIVCE ON 36 AMERICAN RAILWAYS.

Railway.	Locomotives in Service.		Under Consideration.	
	Type.	Weight Lbs.	Type.	Weight, Lbs.
N. Y., N. H. & H.	Pacific	229,500	Pacific	235,000
B. & M.	Pacific	equal to E-43	....	....
N. Y. C. Lines	Pacific	266,100	....	....
Erie	Consolidation	260,100	Mikado	305,000
P. R. R.	Pacific	269,800	....	....
L. V.	Pacific	241,400	....	....
P. & R.	Consolidation	222,000	....	....
B. & O.	Mallet	463,000	....	....
N. & W.	Mallet	400,000	....	....
C. & O.	Mallet	392,000	Mallet	400,000
Virginian	Mallet	455,000	....	....
S. A. L.	Consolidation	212,000	....	....
Southern	Mallet	366,000	....	....
A. C. L.	Consolidation	171,000	....	....
L. & N.	Consolidation	224,000	....	....
Wabash	Consolidation	223,800	....	....
B. & L. E.	Consolidation	254,000	....	....
I. C.	Consolidation	223,000	Mikado	280,000
Pere Marquette	Consolidation	217,000	....	....
M., St. Paul & S. S. M.	Pacific	253,800	....	....
C. & A.	Mallet	323,400	....	....
C. & N. W.	Pacific	238,000	....	....
Great Northern	Consolidation	216,600	....	....
C., M. & St. P.	Mikado	260,500	....	....
C., B. & Q.	Mallet	354,500	Mallet	463,000
A., T. & S. F.	Double Santa Fe	616,000	....	....
C., R. I. & P.	Consolidation	238,900	....	....
N. P.	Mallet	435,200	....	....
M. P.	Pacific	251,000	Mallet	?
S. P.	Mallet	437,000	....	....
St. L. & S. F.	Mallet	416,000	....	....
M., K. & T.	Pacific	228,000	....	....
Grand Trunk	Consolidation	211,200	Mikado	275,000 abt.
Canadian Pacific	Mallet	261,900	....	....
C. N.	Consolidation	181,400	Consol	?
N. Rys. of M.	Mallet	338,000	....	....

Table 4. It is fortunate for our bridges that the stresses produced by the heaviest engines are not in direct proportion to the weight as compared with E-50 type. For instance, the 24-wheel articulated engine weighs 174 per cent more than E-50, but produces increased stresses varying from 15 per cent to 33 per cent, as shown on the table.

without any traffic or speed restrictions; that such a bridge may be subjected to an occasional overload considerably in excess of 50 per cent, and this without speed restriction; and if the speed is regulated, the bridge will stand an occasional overload of 100 per cent.

This statement is consistent with the writer's personal ex-

Railway.	Engine.		Impact.	Tensile Unit.	Equiv. Loading.	Proposed Changes.
	Type.	Weight, 1,000 Lbs.				
P. R. R. West	excess	60.0	....	$7,000\left(1+\frac{M}{M}\right)$	E-65	10 per cent
N. Y., N. H. & H.	E-60	270.0	A. R. E. A.	16,000	E-60	....
A. C. L.	“	270.0	“	16,000	“	....
B. & L. E.	“	270.0	“	16,000	“	....
Pere Marquette	“	270.0	“	16,000	“	....
C., C. & O.	“	270.0	“	16,000	“	....
G. N.	“	270.0	“	16,000	“	....
C. & O.	Artic.	468.0	“	16,000	“	....
C., B. & Q.	Consol.	252.0	Special	$10,000\left(1+\frac{D}{D+L}\right)$	“	....
A., T. & S. F.	“	291.0	....	Special	“	....
W. Md. Ry.	Artic.	488.0	Special	16,000	“	....
P. & R.	E-55	247.5	A. R. E. A.	15,000	“	....
S. P.	Consol.	240.0	....	Special	E-57	....
N. & W.	Special	275.0	Special	15,000	“	....
Virginian	E-60	270.0	A. R. E. A.	17,000	“	....
C., M. & St. P.	E-55	247.5	....	Special	“	....
Southern	E-55	247.5	A. R. E. A.	16,000	E-55	....
I. C.	“	247.5	“	16,000	“	....
C. & N. W.	“	247.5	“	16,000	“	....
C., R. I. & P.	“	247.5	“	16,000	“	....
St. L. & S. F.	“	247.5	“	16,000	“	....
Nat. Rys. of M.	E-60	270.0	....	Special	“	....
C. & A.	E-50	225.0	....	Special	“	....
N. Y. C. Lines	E-60	270.0	A. R. E. A.	18,000	E-53	....
B. & M.	E-50	225.0	A. R. E. A.	16,000	E-50	....
Erie	“	225.0	“	16,000	“	E-60
Wabash	“	225.0	“	16,000	“	....
M. P.	“	225.0	“	16,000	“	E-55
M., K. & T.	“	225.0	“	16,000	“	....
Grand Trunk	“	225.0	“	16,000	“	....
Can. Pac.	“	225.0	“	16,000	“	....
B. & O.	“	225.0	“	16,000	“	....
M., St. P. & S. S. M.	E-55	247.5	....	Special	“	....
L. & N.	Consol.	232.0	A. R. E. A.	17,000	“	E-53
N. P.	“	233.0	....	Special	“	....
L. V.	E-50	225.0	....	Special	E-47	E-60
S. A. L.	“	225.0	A. R. E. A.	17,000	“	....
C. N.	Consol.	211.5	Special	16,000	“	....
P. R. R. East	Pacific	292.0	Special	16,000	E-45	Mallet

Table 3.

Table 4 refers to spans under 100 ft. For greater lengths the stresses will in many cases be less, and in no case will they be in excess of those mentioned above.

Capacity of Bridges.

All bridgemen know that properly designed bridges, as well as steel hopper cars, may be loaded considerably beyond their nominal capacity, and that they will carry a definite amount of overload regularly and continuously without requiring any closer attention than usually bestowed under ordinary good maintenance conditions. This capacity for overload provides to a large extent for future increases and developments.

We know from numerous tests and long experience that bridges properly designed and constructed of proper material and with members proportioned in accordance with specifications equally as good as the standard adopted by the American Railway Engineering Association, so long as maintained in good condition, will safely withstand an overload of 50 per cent

TABLE 4—RELATIVE STRESSES PRODUCED BY HEAVIEST LOCOMOTIVES—SPANS 10 FT. TO 100 FT.

Class.	Actual Weight.	Proportional Weight.	Proportional Stress.	
			From	To
E-50	225,000	1.00	1.00	1.00
Atlantic	214,800	0.96	0.83	1.15
Prairie	244,700	1.09	0.88	1.08
Consolidation	260,100	1.16	0.99	1.14
12 Wheel	262,000	1.17	1.00	1.14
Decapod	267,000	1.19	0.96	1.07
Pacific	270,000	1.20	0.93	1.08
Mikado	305,000	1.36	1.02	1.16
12 Wheel Articulated	334,500	1.49	0.98	1.15
10 Coupled	361,000	1.60	1.00	1.26
20 Wheel Articulated	478,000	2.12	1.01	1.14
16 Wheel Articulated	493,000	2.19	1.26	1.34
24 Wheel Articulated	616,000	2.74	1.15	1.33
12 Wheel Electric Motor	300,400	1.33	0.83	0.98
16 Wheel Electric Motor	320,000	1.42	0.84	0.93

perience with the maintenance of structures in the past 25 years, and is somewhat more conservative than has been the successful practice of a number of railway engineers. Therefore, it should be clearly understood by the operating officials of railways that a bridge of the nominal E-50 capacity, that is, one designed for Cooper's E-50 loading in accordance with the American Railway Engineering Association's Standard Specifications, will not reach its full regular traffic until the different classes of engines now in service shall have about the weights given in Table 5, and an E-60 bridge not until these engines have increased to the extent shown in Table 6.

The capacity of these classes of bridges when subjected to occasional loads or to regular loads operated under restricted speed will be considerably in excess of that indicated above. For example, an E-50 bridge with an overload of 75 per cent which, when the bridge is in good condition and up to the American Railway Engineering Association Standard in design, is perfectly safe for occasonal loads or regular loads under restricted speed, will carry engines weighing in excess of the engines now in use to about the extent indicated below:

16 and 24-Wheel Articulated Engines	30 per cent
10-Coupled	39 per cent
Mikado, 12 and 20-Wheel Articulated, Atlantic, Consolidated and 12-Wheel Type Engines	52 per cent
Pacific and Decapod	62 per cent
Prairie	70 per cent
Electric	79 to 88 per cent

It will be seen from the above that loads which strain an E-60 bridge to its *regular service capacity* can be operated *occasionally* over an E-50 bridge, and *even regularly when speed is restricted.*

Have Present Bridges Sufficient Strength?

In view of past experience, it is perhaps reasonable to assume that some of the heavy types indicated on Table 5 as developing the full regular service capacity of an E-50 bridge may probably be operated regularly over heavy grade divisions, but experience with the present heaviest locomotives does not indicate that still heavier types will ever be proper and economical on low-grade divisions. But suppose they should be operated regularly on all divisions, whether high or low grade, then an E-50 American Railway Engineering Association Specification bridge will have ample capacity to take care of them.

It is less reasonable to assume that the still heavier types of Table 6 required for developing the full regular service capacity of an E-60 bridge will ever be operated even on high-grade divisions, unless gage of track is increased and greater clearances made, both laterally and vertically, in tunnels and bridges and the right-of-way probably also increased, or, in other words, unless all present standards are abandoned and the railway practically reconstructed.

But suppose such types can be constructed and placed in operation without changing standard gage and clearances, they surely would not be operated regularly on low-grade divisions, and if their regular operations should be confined to high-grade divisions, then E-50 bridges on low-grade territory would have ample capacity to enable these types being transferred to and from these high-grade territories.

It appears, therefore, than an E-50 bridge is a good and economical type and provides for increased loading above the heaviest now in service to a sufficient extent to justify the railways which consider it a proper standard on all divisions until such time as conditions require practically a complete reconstruction of the railway.

It is, of course, admitted that an E-60 bridge is heavier, stronger and stiffer than an E-50 bridge. It will stand more abuse and more neglect, but it will cost from 12 per cent to 15 per cent more for its construction. While a number of roads have adopted this class of bridge for all divisions and others are contemplating its adoption, the justification therefor is not apparent in many cases.

This tendency toward the adoption of E-60 loading is perhaps influenced more by precedent than by good, sound reason and judgment, and is being stimulated by the bridge companies, who profit by a greater tonnage of metal used in construction.

The writer hopes it will not be inferred that he condemns E-60 bridges as unreasonably heavy and extravagant and, therefore, not consistent with economical construction. They are better bridges than the E-50 class, and those who are in a position to justify them in paying more for the stronger structure, or who honestly believe this reserve strength will be required in the future, should not be classed with the extravagant, since at the most it is a case of foresight and judgment.

While E-60 bridges are stronger than those of E-50 class, it is probable that if the weights of engines ever increase to an extent sufficient to develop their capacity, many of these bridges, as now being constructed, will not have sufficient clearance to enable such excessively large locomotives to be safely operated. If, therefore, E-60 bridges are constructed, it would be well to provide a lateral clearance of at least 8 ft. from the center of track and an overhead clearance of not less than 25 ft. above top of rail, in which case there will be some possibility of operating over them the excessively large locomotives required to develop their strength.

Those roads which prefer stronger bridges on account of severe and heavy service on high grades could reasonably adopt the E-60 as standard for high-grade divisions and E-50 for low-grade divisions.

Conclusions.

(1) It is reasonable to assume that rolling loads of sufficient weight to develop the full regular service capacity of an E-50 bridge, as indicated in Table 5, will probably be operated regularly over heavy-grade divisions, but it is doubtful whether such types will ever be regularly operated over low-grade divisions.

(2) It is less reasonable to assume that rolling loads of the weights necessary for developing full service capacity of an E-60 bridge, as indicated in Table 6, will ever be operated even on high-grade divisions, unless present standards of gage, roadbed and clearances are abandoned and the road practically reconstructed.

(3) An E-50 American Railway Engineering Association Specification bridge is a good and economical type with sufficient strength to safely carry, in regular unrestricted service, the heaviest locomotives that can be safely operated without a possible complete revision of present standard clearances.

(4) An E-60 bridge is heavier, stronger and stiffer than an E-50 bridge and its construction will cost from 12 per cent to 15 per cent more. It will safely carry the heaviest loads

TABLE 5—FULL REGULAR SERVICE TRAFFIC CAPACITY FOR E-50 BRIDGES BASED ON AN OVERLOAD OF 50 PER CENT.

Locomotives.	Weight.	Wheel Base.	Average Axle Load.	Percentage of Increase.†
Cooper's E-75	337,500	23.00	75,000	50.0
*Atlantic	280,000	30.79	82,400	31.0
Prairie	356,300	34.25	82,600	46.0
Consolidation	342,300	26.50	75,600	32.0
12-Wheel	344,800	27.08	73,000	32.0
Decapod	374,300	29.83	66,400	40.0
Pacific	375,000	35.20	81,700	39.0
Mikado	394,200	35.00	77,900	29.0
12-Wheel Articulated	436,200	30.66	72,600	30.0
10-Coupled	429,800	43.50	71,700	19.0
20-Wheel Articulated	629,000	59.80	70,800	32.0
16-Wheel Articulated	552,000	40.17	62,800	12.0
24-Wheel Articulated	695,000	65.92	62,000	13.0
12-Wheel Electric	460,000	38.50	78,800	53.0
16-Wheel Electric	516,000	44.22	64,500	61.0

*The Atlantic type applies to spans under 15 ft.; for greater spans the weight of this class of engine would run over 60 per cent. in excess of the heaviest type now in service.

†Percentages of increase in column 5 represent the approximate increase in weight of locomotives and driving loads in excess of the maximum weights now in actual use.

TABLE 6—FULL REGULAR SERVICE TRAFFIC CAPACITY FOR E-60 BRIDGES BASED ON AN OVERLOAD OF 50 PER CENT.

Locomotives.	Weight	Wheel Base.	Average Axle Load.	Percentage of Increase.†
Cooper's E-90	405,000	23.00	90,000	50.0
*Atlantic	336,000	31.79	98,800	57.0
Prairie	427,600	34.25	99,100	75.0
Consolidation	411,000	26.50	90,700	58.0
12-Wheel	413,500	27.08	87,600	58.0
Decapod	449,400	29.83	79,500	68.0
Pacific	450,000	35.20	98,000	67.0
Mikado	473,000	35.00	93,500	55.0
12-Wheel Articulated	523,800	30.66	87,100	56.0
10-Coupled	515,800	43.50	86,000	43.0
20-Wheel Articulated	754,800	59.80	85,000	58.0
16-Wheel Articulated	662,500	40.17	75,400	34.0
24-Wheel Articulated	834,000	65.92	74,400	35.0
12-Wheel Electric	552,000	38.50	94,600	84.0
16-Wheel Electric	619,200	44.22	77,400	94.0

*The Atlantic type applies to spans under 15 ft.; for greater spans the weight of this class of engine would run over 90 per cent. in excess of the heaviest type now in service.

†Percentages of increase in column 5 represent the approximate increase in weight of locomotives and driving-axle loads in excess of the maximum weights now in actual use.

that it is possible to conceive of, but if the weight of engines ever increases sufficiently to develop its capacity, bridges as now constructed will probably not give sufficient clearance to enable such enormous locomotives to be safely operated.

(5) The tendency of railways is toward the adoption of E-60 bridges, but this in many cases appears to be influenced more by precedent than by good, sound reason and judgment, and it is stimulated by those who profit thereby on account of the greater tonnage of metal used in construction.

(6) If an E-60 bridge is considered warranted by the heaviest power likely to be operated, its proper place is on high-grade divisions, and it would, therefore, be good engineering practice to construct E-50 bridges on low-grade divisions, since they will have sufficient strength to permit the occasional operation to and from high-grade territories of the heaviest equipment which could be operated on the E-60 bridge in regular service traffic.

(7) E-60 bridges would be more consistent if constructed with greater clear width and height than sanctioned by present standards, because this would provide for probable increased width and height, as well as weight, of the enormous rolling stock required to develop their capacity.

The Signal Department

AUTOMATIC BLOCK SIGNALS AT CALVIN, OKLA.

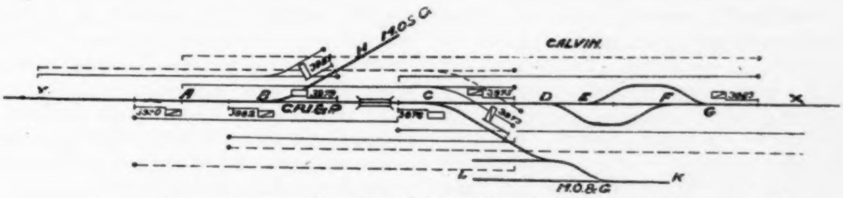
Calvin, Okla., is on the east bank of the South Canadian river. In 1908-9 the Missouri, Oklahoma & Gulf Ry., in extending its line south, built along the west bank of the river above Calvin and, in order to get into Calvin and to the east bank of the river without delaying to build a bridge, requested permission to use temporarily the single track and bridge of the Rock Island. This permission being granted, a connection was made with the Rock Island on each side of the river as shown in the figure.

When this proposition was first mentioned the writer was asked to design a system of signaling that would fully protect the situation and yet be economical. In fact, he was given to understand that the usual arrangement in such cases, that of interlockings at B and C with a manual or a controlled manual block between the two, would be prohibitive on account of the considerable expense for operation. Therefore, the scheme of protection fixed upon was that of signals working automatically and located as shown in Fig. 30. This is a "first come, first served" arrangement. Stopping to register is not necessary. All the approach of a train, then a flagman must protect in the direction of the expected train before the switch may be moved so the M. O. & G. train can come out on the Rock Island; if both indicators show approaching trains, then flagmen must protect in both directions on the Rock Island before the switch may be moved or else the train must wait on its own track until the indicators have changed to show a clear line.

Moving switch B for the M. O. & G. sets signals 3990, 3982, 3979 and 3975 at "stop" and in addition, signal 3963 at "proceed, prepare to stop at next signal." This operation, if the track is clear between signal 3979 and Y, also permits signal 3981 to assume the "clear" position.

Moving switch C for the M. O. & G. sets signals 3976, 3982, 3975 and 3963 at "stop" and signal 3990 at "proceed, prepare to stop at next signal." This operation, if the track is clear between signal 3975 and point A, also permits signal 3973 to assume the "clear" position.

The solid lines, each beginning with a circular dot opposite the signal to which it pertains and ending in a straight hook, show the sections of track over which the "stop"



Automatic Block Signals at Calvin, Okla., C., R. I. & P. Ry.

trains on both roads are required to obey the signal indications.

M. O. & G. trains from the north head out on the Rock Island at B, back over the bridge through the switch C to track K, and then proceed southward on track L. M. O. & G. trains from the south head into track K, back through the connection and switch C to A, and then proceed northward through switch B on track H.

As stated above, the signaling for these junctions and the track adjacent to and between them is wholly automatic. Signals 3981, 3979 and 3976 give two indications, "stop" and "proceed at speed." The other signals, 3990, 3982, 3973, 3975 and 3963, give the indication, "proceed, prepare to stop at next signal," as well as the indications "stop" and "proceed at speed." Thus it is seen that each of these latter five signals repeats the indication of the next signal in advance.

Two indicators are provided at each of the switches B and C, and one indicator at each of the switches D, E, F and G. At switch B, the eastward indicator will be at stop with a train between Y and signals 3981 and 3979, and the westward indicator will be at stop with a train between signals 3975 or 3973 and signal 3982. At switch C, the eastward indicator will be at stop with a train between Y and signals 3973 and 3975, and the westward indicator will be at stop with a train between X and signal 3976. At the switches D, E, F and G, the indicators will be set at stop with a train between A and signal 3963.

Trains of the M. O. & G. must not enter on the Rock Island track at switches B or C if either indicator at the switch indicates the approach of a train, unless fully protected by a flag. If both indicators are at clear, a trainman may open the switch and the train may proceed; but, if only one indicator is at clear and the other indicates indication of the signals is given. The broken lines refer to those signals giving the "proceed, prepare to stop at next signal," indication.

Thus it will be seen that between the points B and C full signal protection, both for following and head-on movements, is given.

Trains on the Rock Island have only to observe and obey these signal indications as prescribed above, and which is the same for all single track automatic block signals.

That this system of signaling for such a situation is safe and satisfactory is exemplified by the fact that no criticisms have been made and no collisions have been reported. There have been, however, some cases of disregard of signals, but it seems certain the superintendents concerned have handled these so summarily and vigorously that the offenders are careful not to repeat them.—Rock Island Employes' Magazine.

The general revision of grades on the Delaware & Hudson between Nineveh, N. Y., and Oneonta, 37 miles, has been completed. The work involved 10 miles of track and cost $250,000.

The Erie R. R. is planning to have work started this spring on the double tracking of its line from Marion, O.

Grading on the line of the Hawkinsville & Western has been completed as far as Grovania on the Georgia Southern & Florida. The officers expect to have the road completed to Grovania within the next 30 days. Five miles of track have been laid from Hawkinsville.

The Simplex Railway Appliance Co., Hammond, Ind., has been incorporated in Delaware with $1,000,000 capital stock, to make interurban, street and steam railway cars, trucks, wheels, etc. Harry H. Philips, president, and Paul A. Neuffer, secretary.

The Maintenance of Way Department

MAINTENANCE OF WAY EFFICIENCY METHODS, ERIE R. R.

During the past four years there has been developed in the maintenance of way department of the Erie R. R. an improved and comprehensive management system to promote efficiency by extending supervision of the engineer of maintenance directly over all of the work of the department, by placing all work in a definite schedule and under a fixed method of procedure, and by concentrating to the greatest possible extent the experience of all men in responsible positions in this branch of the work for the general good of the department. The plan aims to keep the roadway and related structures up to a high standard of maintenance with minimum consistent expenditure. It represents the application in one important department of a principle which is being extended over the entire operations of this road, that of getting the greatest possible value out of a dollar's expenditure. New plans for improving efficiency in the mechanical and operating departments also are now being followed.

The fundamental parts of the new plan for the maintenance of way department have been in operation from two or four years, so their utility is now quite well established and the working details are practically completed. These details are being formulated with a view to give greater assurance that thoroughness is extended to all parts of the work and that the desired standard of work is maintained. Economy is sought in the reduction of effort in the accomplishment of a given result in the different operations which make up the routine work; in lengthening the useful life of materials employed and in the elimination of unwarranted experiments. Working methods are continually studied in this connection, so that improvements may be introduced as fast as their value is demonstrated.

In general, these results are accomplished by a system in which reports and recommendations are made to the engineer of maintenance of way on the basis of local inspection by division officials, the recommended work being then personally inspected by the engineer of maintenance and a complete detailed program made of the authorized work for each season, by which the division engineers direct their operations. The methods of carrying out this work are standardized as far as practicable. Meetings of the principal division employes at the end of the season, attended by the engineer of maintenance of way, serve to summarize the results and experiences of that season, and to apply them to the production of better results in the following season.

In the preliminary work on each division, regular inspections are made by bridge inspectors, track foremen and supervisors, and all matters needing attention in their estimation are placed in a report to the division engineer on forms provided for the various classes of work. The bridge and building inspections are made monthly and quarterly by the inspectors, and by the master carpenter semi-annually in May and November. Records of these regular inspections are made in a report book carried by the inspector, which contains a number of blank forms. A sheet is provided for each structure, showing all items to be noted in its examination. Instructions are printed in the book, explaining how an inspection should be conducted on different kinds of structures. These reports are filed in the office of the division engineer.

In August the division engineer goes over all structures in company with the master carpenter and prepares a report which contains data similar to that included in the regular inspector's report. This is sent to the division superintendent, who forwards it to the engineer of maintenance before September 15. Other inspections are also made by the division engineer where special conditions require them.

Track and roadway inspections for the determination of new work are made in the spring, as soon as the frost is out of the ground, and are conducted similarly to the bridge and building inspections, the supervisors reporting to the division engineer. In the preparation of his recommendations on this work, the division engineer is guided by his office records and his knowledge of the conditions on the division and where the conditions or the extent of the work require it he makes a personal inspection. A report on ballast and ties and one on rails is submitted to the engineer of maintenance of way.

When the bridge and building reports from all divisions have been received in the office of the engineer of maintenance of way, a joint inspection by the maintenance of way department and the engineering department is made for the authorization of work to be done. This trip is started during the first ten days of October and usually occupies about a month. The inspection party includes the engineer of maintenance of way, the engineer of bridges and other officials whose work is related directly to roadway and structures. Each division engineer goes over the proposed work on his division with this party and the improvements listed by him in his recommendation to the engineer of maintenance of way are discussed. Certain of these are approved and others are deferred, according to the judgment of the engineer of maintenance, the estimates of material and labor being checked on the approved work. The engineer of maintenance of way makes a complete record of the proceedings and approved work on each division at the time of the inspection, this record being used later in the preparation of a general improvement program in his office. If he revises the recommendation of the division engineer on a structure, the details of the work as revised are entered in this record.

When the inspection of all divisions is completed, a general schedule for the next season's work is prepared in the division office on the basis of the original recommendations and the revisions made by the engineer of maintenance of way. Copies of the schedules for each division are received at the headquarters office and are bound into a general improvement program, which is submitted to the general superintendent for approval. The sheet for each division on the bridge and building program lists all structures on which work is to be done. Each item of repairs is entered for this structure with the necessary labor and materials. Separate columns are provided on the sheet for the different kinds of work necessary for the repair of such structures. For example, under a certain bridge entered for repairs, there may be listed the pointing of abutments, painting, and renewal of a number of ties. The estimated expense of labor and material on the first item would appear under a column headed masons, the second under painters, and the third under carpenters. The total cost of all work on that structure would appear in a column of totals on the right of the sheet, while the total of any of these classifications of work on all structures on the division would appear at the foot of corresponding column. As the work on this program is reported to be finished by the division engineer it is checked off on the sheet.

Programs of a somewhat similar nature are made up for ballasting, ties, and rails. In the case of the ballast and ties, there is a sheet for each division on which the location and extent of all work of this character is noted. On this sheet a column is given to each month in which work of this character is done and a certain amount of it is assigned, together with a specified number of gangs.

The program for rail renewals is very similar to that for ties and ballast, showing the location, extent, and gangs required.

The labor estimates used in making up these programs are obtained from standard practice cards covering various subdivisions of the work of the maintenance of way department. These cards are prepared from the experience of the department over a long period of observation in each of the processes treated. Sets of cards furnished to the foremen direct them in the conduct of all routine work in certain predetermined ways and with predetermined forces which have been found to be most economical.

The standard practice cards are printed in plain bold type on white index cards, 4x6 ins., provided for binding in a loose-leaf binder. Each card treats of one detail of the work under a subdivision. For example, one card will treat of laying rail, showing in detail the force to be employed, specifying the duties of the various men and describing the method to be followed. Another card is devoted to loading and unloading rail, showing the force required, the positions taken by the men and the method followed. Ballasting, tie inspection, tie renewals and other operations are similarly treated. Other cards show maintenance of way standards with drawings and outline the progress of a season's work by regular section forces in such manner as to carry on the work most effectively and to reduce losses of time.

In following out the maintenance of way program in a season's work it is required that everything be completed according to the schedule, but it may be completed in advance. If the later is the case, the increased speed acquired may be the result of some special local effort, which may be discussed at the division meeting later on, so as to lead to general improvement in the working methods in this particular respect. Daily reports from the division engineers to the engineer of maintenance keep the headquarters office closely in touch with the progress of the work on the various divisions. Materials are provided as demanded by the program, and delays in shipment are eliminated by the advance information which it gives in regard to the supplies needed. The ballast and tie records show accurately the amounts of those supplies required at any point within a given month, and arrangements for rail renewals are similarly outlined. Relaying rail is stored in three classifications upon its removal from the track. This work is simplified by having the supervisor caliper the rail immediately upon removal and mark it at that time as follows: One, two or three stripes of paint across the head, respectively, for rails suitable for reuse in main track, side track or discard, respectively.

In the schedules of bridges and buildings, ballast, ties, and rails, the engineer of maintenance of way has a condensed record to which he may refer at any time to learn what work is being done on a certain division, what progress has been made in this work, what forces and materials are being employed at any point at a give time. The division engineer and each of his assistants has a definite program and plan of operation by which they direct their work, enabling the forces to carry it out in a manner which has been selected as being most efficient and to do so without delays.

A feature of the annual inspection trip of the engineer of maintenance of way is the practice of holding meetings of the division employes to discuss matters which have come up in connection with the season's work. At these meetings from 30 to 100 men are present, including the division engineer, supervisors, foremen and others. They are usually held at a dinner, and the men are given an opportunity to mingle and take advantage of the social as well as the practical opportunities of the gathering. In going over the recommended work on the division, the engineer of maintenance has also inspected the work of the season just completed, and he reviews this in the meeting, asking for a general discussion from all those present. Methods of handling detail work and the experiences and opinions of the men are brought out in these discussions and are recorded in minutes for further consideration in the headquarters office and in the division offices. These meetings are an important factor in developing means of carrying out work in the manner best suited to the local conditions on a particular division. They also frequently bring out or modify points which are incorporated in the standard practice cards and thus bear a direct relation to the fixing of cost on certain details of the work on that division. The practice of holding division meetings has now extended over a period of about two years, and the men show an interest in this phase of the work, which indicates that they will continue to be an important part of the plan.—*Engineering Record.*

THE TURNOUT.*

By F. S. Stevens, Eng. M. of W. P. & R. Ry.

The earliest form of switch was probably the stub, because no machine work was required to make it and a blacksmith could soon make the rods and some form of operating appliance. Frogs were made of wood, plated with iron or steel, and frogs of this kind were used long after tee or pearhead rails came into use, and cast-iron frogs plated with steel did not entirely displace them.

The split or point switch, as now known, came into general use with the steel rail and the rail frog and the increase in wheel loads beyond the limit of endurance and economical maintenance of the earlier forms of turnout material. Several forms of so-called improved switches have been used to some extent, but none of them has met with universal approval; most of them, however, have merit and continue to be used where conditions are such that a split switch is not entirely satisfactory. Some of these improved switches are used with frogs of ordinary type, but leave the track otherwise unbroken and carry the wheel flanges over the main rail on the turnout side; others leave the main track unbroken at the frog and carry the wheel flange over the rail, and others leave the main track absolutely unbroken; all of them, however, are subject to dangers and troubles caused by worm wheels and the relative insecurity of the track where the wheels are elevated to pass over the main rails. It appears, therefore, to be a case of the survival of the fittest and it may probably be safely assumed that the split switch has come to stay.

The most symmetrical and the most desirable form of turnout from an operating standpoint would, of course, be a continuous curve from point of switch to point of frog, the curve being tangent to center line of track at both points, and meeting the conditions imposed by the old approximate rule making the turnout distance equal to twice the width of the gage multiplied by the number of the frog; however a switch that would make such ideal conditions as to installation and operation possible, has not yet been invented, the nearest approach being the split or point switch, making an angle of approximately one degree with the main rail.

*Extracted from Bulletin 139, Railway Engineering Association.

Where switches of this angle are installed, speeds of from thirty (30) ft. to thirty-five (35) ft. per second can be maintained over them with little discomfort, and as at this speed the turnout curve of approximately three degrees that would be used with a No. 15 frog can be operated without superelevation and with less discomfort than is caused by the change of direction at the point of the switch, it follows that frogs of less angle need not be used unless other conditions than speed of operation over turnouts become the governing factors.

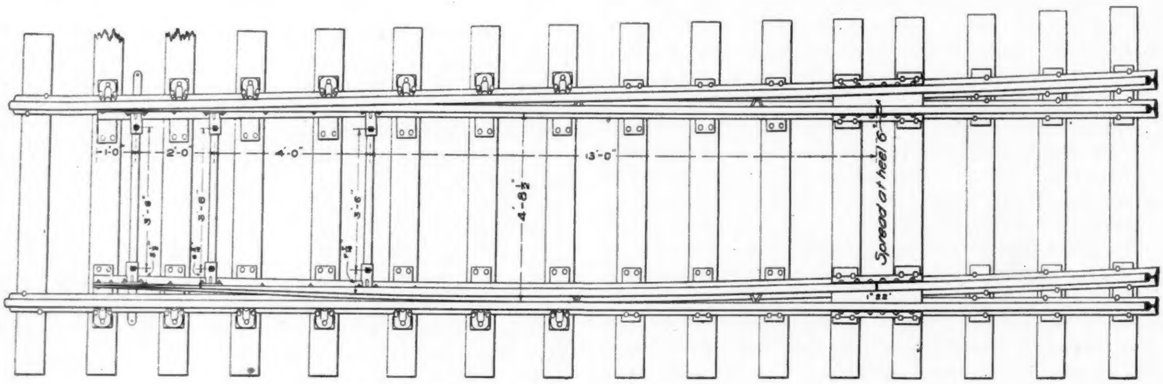
It has been demonstrated frequently that where switches with thick points are used and the extreme points are struck at intervals by passing wheels, the metal wears off rapidly because after the wheels strike such points they recoil, the switch rails soon become very blunt and cars with hard worn or sharp flanges are liable to be derailed. This condition is seldom found where switches with fine and well-fitting points are used, because such points provide a relatively smooth surface for the flanges of the wheels to follow.

There may be some difference of opinion as to the proportions or ratios that produce the most symmetrical appearance in turnouts where split switches are used, but common practice appears to confirm the view that in ordinary main line and yard work the frog angle should be generally not less than approximately four times the switch angle.

through the radial line at the point from which the diagram will rotate to the point to be reached, the greatest radius possible with the frog angle assumed will be shown, and as the radius of the turnout curve should be a little longer than the radius of the curve back of the frog, the use of the diagram will also show whether the frog angle assumed is the proper one or not, and if not, whether a less or greater angle should be used.

In arranging for new installations the first and most important matter is to decide on the angle of frog most suitable to be used or that will best meet the conditions as to room available, character and volume of traffic to be handled and speed of movement.

If the question is one of maintaining speed or avoiding unnecessary loss of time by reduction of speed in passing through turnouts or crossovers, the switch angle instead of the frog angle becomes the more important matter for consideration, because the angle of the switch causes an abrupt change in direction without any easement whatever. Therefore, to reduce the shock as much as possible, the angle is reduced in our longer and easier switches to approximately one degree, but this is too great a change in direction to be made at high speed. In some cases it is possible to overcome most of the trouble by placing the frog on the center line of track, thus bisecting both the frog angle and



Suggested Standard 20 Ft. Switch.

If this practice were followed a switch ten (10) ft. long would not be used with a frog of less angle than No. 5, a switch fifteen (15) ft. long would not be used with a frog of less angle than No. 8, a switch twenty (20) ft. long would not be used with a frog of less angle than No. 10, and a switch twenty-six (26) ft. long would not be used with a frog of less angle than No. 15, and the writer thinks that very few frogs of less angle than No. 15 would be used, and only under unusual conditions, so that frogs of less angle need not be considered, except for special work.

In addition to the suggestion as to a desirable ratio between the angles of the frog and switch to be used in a turnout, it is proper to invite attention to the advantage that can sometimes be gained where length of radius is the controlling factor, by curving both switch and frog, using a frog of the least angle that will meet conditions and turning part of the angle back of the frog, thereby increasing the radius and making it possible in some cases to operate engines the use of which would otherwise be prohibited.

In cases where room is limited and it is important that the greatest possible length of radius be used, some time can generally be saved by making a diagram on tracing linen of the frog angle to be used and from the intersection of the gage lines draw the radial lines; then by placing this tracing over the plan of existing track and sticking a pin

the switch angle as to change of direction of moving trains and thereby avoid the necessity for material reduction in speed. In either case, however, it appears that the use of frogs of a less ratio than one to fifteen is unnecessary, because on account of light curvature the change of direction after passing the switch at proper speed is made without discomfort and in safety.

In this connection it is proper to invite attention to the difficulties to be met in properly constructing and maintaining switches of extreme length and to the little, if any, advantage that is gained by their use.

Switches of all lengths and angles should be provided with heel blocks to fill the space between the heel of the switch and the stock rail fitting the rails as snugly as any other splice bar. The stock rail should pass at least six (6) ft. beyond the heels of switches so that the ills that are caused by joints placed close together may be avoided. These conditions could not be produced, of course, by using rails thirty-three (33) ft. and switches thirty (30) ft. in length.

It may not be unreasonable or improper to suggest twenty-six (26) ft. as a suitable length for a maximum limit when fair speed must be maintained. The angle would be approximately one degree and the joint at both heel and toe of switch could be made to clear the joints in the main line rail.

Switch rails need the rigid and ample support at their heels that apparently cannot be supplied except by heel blocks, and if the heel blocks are properly fitted and afford the same support as angle bars and the bolts pass through the holes bored in the body of the stock rails instead of through the holes provided for a splice, the heel of the switch is properly and efficiently supported.

It is important that the entire length of the switch be carried on suitable switch plates with a uniform height of riser throughout. It is also important, and particularly so in turnouts of short radius, that the turnout rails be accurately curved, because if rails are sprung into place and spiked there they will gradually draw the entire turnout out of line, and to avoid unnecessary joints and additional expense of maintenance it is desirable that the lead and turnout rails be cut at the mills to proper length, so that both frog and switch can be spliced to the same rail and the greatest possible rigidity obtained.

Another matter of importance is the fact that all switch rails in being moved or shifted from one position to the other must either be curved alternately throughout their length, as will be the case if firmly and properly held by the splice bars, or they may swing freely, making an angle at the heel, as may be the case if the switch is neglected and the splices are allowed to become so loose that they act merely as hinges.

It is evident that to have switches that will work freely and be easy to operate it is necessary that they should work as well with two or three rods on them as with one, and that to secure this result it is necessary that the rods should fit without strain at all times. To accomplish this it is necessary to treat one rail as being straight or a part of the main track and the other as a curve. The distance from back of switch rails to center of hole in the lug in all cases should be one-half of the distance remaining after subtracting the distance between centers of holes in the switch rods from the total distance back to back of switch rails, thereby securing an equal distance from back of switch rail to center of hole on opposite sides and making all switch rails of one angle of planing interchangeable.

SURFACING.

Editor Engineering:

My ideas as to gang organization are as follows: When ballasting with crushed rock, 10 to 12 inch raise where it is desired to make a general surface out of face for a division 100 miles long or more, my method of organization would be as follows: One general foreman or walking boss; one assistant foreman, clothed with same authority as to disciplining men under him as the gang foreman; one timekeeper; one good track surfacer; two straw bosses; one tool man. The straw bosses should be paid 25c each per day more than common laborers. The tool man and water boys should have laborer's wages. The general or gang foreman should report to the roadmaster; and the assistant foreman, timekeeper, etc., should report to the gang foreman, who should also have a free hand in the management of the boarding camps where contractors are boarding the men. This will more likely insure an honest deal for the men from the commissary clerk, cooks and camp force. A recommendation from the foreman for change of any camp forces should be approved. In fact, he ought to be the roadmaster's and contractor's representative. In a gang of this size the contractor should board the foreman, his assistant and timekeeper and take only half rates for the track raiser and the two straw bosses. This will insure the hearty co-operation of the entire administrative force and result in better board for the men, a saving of supplies for the contractor, and prevent contention between the foreman and boarding contractor. I recommend not over 12 men to each sleeping car. This leaves room in car for two to four small tables for papers, games, etc., in evenings and on Sundays. The number of cars for this organization would then be 16 bunk cars, 2 large dining cars, 1 kitchen car, 1 commissary car, 1 grocery car equipped with ice box, 1 office car, 1 water car, 1 coal car, 1 tool car, all in charge of 1 camp watchman.

The raise of 10 to 12 inches, ballast distributed by center dump cars, may be carried on by 2 to 4 jacks until the work is opened, when 2 good jack gangs will usually keep ahead. On a raise of this kind I allow 2 inches for settling, the large gang to be followed by a straw boss with 10 or 15 men raising low joints, smoothing up, lining, and placing track in condition to receive 30 to 35 mile per hour traffic. The ballast is run in by the large gang with shovels, while the spotting gang uses tamping picks. The track is now ready to receive a second and finish covering of ballast, which may be put on with a second large gang of the same size, organized in much the same manner. This program may be carried out over 200 miles of road, working these gangs in pairs on 10 or 15 mile sections, giving the first gang sufficient start of the finishing gang to prevent crowding. The finishing should be done by the best foreman on the division, chosen on account of his skill and ability. The first man having allowed 2 inches for settling, the track will be found to be 1 to 3 inches below grade, so that the finishing gang has from 1 to 3 inches lift, which should be pick tamped 12 to 14 inches inside the rail. This surface will give good results, and remain at grade. The work should average from 32 to 35 feet per man per 10-hour day. I never permit gangs to go to camp for dinner after they get one mile out. It is easy to arrange this where roadmaster and boarding contractor work hand in hand. I have decided objections to the many unskilled section foremen making a general surface. The knack of surfacing track is a gift and should be entrusted only to skillful men. This is especially true with small gangs, where the foreman has no grade stakes. I make a practice (in surfacing with small gangs) of doubling up section gangs to place the work in charge of my best men and lift a few miles each year.

Roadmaster.

Personals

Henry S. Elliott has been appointed division engineer of the Erie, with office at Hornell, N. Y., succeeding H. C. Landon, resigned to accept service elsewhere.

F. J. Parkhurst has been appointed acting roadmaster of the Indianapolis & Michigan City division of the Lake Erie & Western with office at Peru, Indiana, succeeding D. N. Correll, deceased.

J. A. Zehner has been appointed division engineer of the Lehigh Valley with office at Hazelton, Pa., succeeding Mr. M. H. Elkin, deceased. Mr. F. N. Loughnan has been appointed division engineer with office at Wilkes-Barre, Pa., succeeding Mr. J. A. Zehner, promoted.

R. H. Hunter has been appointed acting assistant superintendent of the Idaho division, of the Oregon Short Line, with headquarters at Pocatello, Idaho. H. W. Joslyn has been appointed assistant superintendent of the Idaho division of the Oregon Short Line, with office at Glenns Ferry, Idaho.

W. C. Armstrong, terminal engineer of the Chicago & Northwestern, has been appointed engineer of bridges, with office at Chicago, succeeding I. F. Stern, who has resigned to engage in private practice.

F. Merritt, chief engineer, S. F. Clapp, general foreman of bridges and buildings, and T. A. Wood, purchasing agent of the Gulf, Colorado & Santa Fe, have had their jurisdicman, Tex., to mile post 461.
tion extended over the Pecos & Northern Texas from Cole-

R. F. Carley has been appointed chief operating engineer of the Illinois Traction System, succeeding W. H. Thompson, with office at Peoria, Ill.

W. H. Thompson has accepted a position as general manager of the Des Moines Electric at Des Moines, Ia.

M. M. Cooke, formerly assistant engineer of the Wichita Falls Route, has been appointed chief engineer of the Wichita Falls & Northwestern and the Wichita Falls & Southern, with office at Wichita Falls, Tex.

Burt Anderson has been appointed assistant signal engineer of the Atchison, Topeka & Santa Fe, with office at Topeka, Kan. Edgar Winans has been appointed signal supervisor, with office at Los Angeles, Cal., succeeding P. B. Hyde, resigned to accept a position elsewhere.

H. E. Brashares, formerly signal supervisor of the Chicago & Western Indiana, has resigned to accept an appointment as inspector of signals of the Great Northern, with office at St. Paul, Minn. Mr. Brashares succeeds C. R. Hodgdon, who was recently appointed signal engineer of the Canadian Pacific.

T. A. Palmer, roadmaster of the Chicago, Rock Island & Pacific at El Dorado, Ark., has been appointed roadmaster of sub-divisions 54 and 55, and part of 53, succeeding George Woods, transferred. The office is at El Dorado. S. J. Rufer has been appointed roadmaster of sub-division "A" and part of sub-division 53, succeeding Mr. Palmer.

W. F. Muff, roadmaster of the Middle division of the Atchison, Topeka & Santa Fe, has resigned to engage in other business.

M. J. Brundage, formerly with the signal department of the Chicago, Rock Island & Pacific, has accepted the appointment of signal supervisor of the Chicago & Western Indiana. He succeeds H. E. Brashares, who has accepted a position with the Great Northern.

H. C. Landon, formerly division engineer of the Erie, has been appointed general manager and chief engineer of the Watanga R. R., a new line. The office is at Leenoir, N. C.

Frank V. Marshall, assistant engineer of the Wabash at Decatur, Ill., has been appointed engineer of maintenance of way, succeeding Edward Shelah, who has been appointed assistant engineer. Their offices remain at Decatur.

M. M. Hatch, chief draftsman of the Boston & Maine at Boston, Mass., has been appointed engineer of tests of the New York, New Haven & Hartford and the Boston & Maine. His office will be at Boston, Mass.

W. J. Long has been appointed division engineer of the Grand Rapids division of the Pere Marquette, office at Grand Rapids, Mich., succeeding J. P. Reynolds, who has been appointed division engineer of the Petosky division, office at Traverse City. William Madden, formerly division engineer at Detroit, has been appointed engineer of the Buffalo division, office at Port Huron, Mich. V. E. Duncan has been appointed engineer of the Ionia division, office at Ionia; the supervision of A. L. Grandy, division engineer, Saginaw, Mich., now covers the Toledo, Ludington and the S. T. & H. divisions. John Robinson, supervisor of bridges and buildings at Grand Rapids, has been transferred to Traverse City, Mich. C. F. Weir, formerly supervisor of bridges and buildings at St. Thomas, Ont., has been appointed foreman of bridges and buildings at Port Huron, Mich. W. E. Shaffer has been appointed foreman of water service of the Buffalo division, office at Port Huron, Mich. A. McNab, supervisor of bridges and buildings at Holland, has been transferred to Grand Rapids, and G. Y. Whitmee, foreman of water service, with office at Grand Rapids, will have jurisdiction over the entire Grand Rapids division. A. Gustafson, roadmaster at Muskegon, has been transferred to Traverse City, Mich.

Mr. C. E. Knickerbocker has resigned as chief engineer of the New York, Ontario & Western, and Mr. J. H. Nuelle has been appointed engineer maintenance of way in charge of maintenance and repairs of bridges, buildings and track. The office is Middleton, N. Y.

W. F. Muff has resigned as roadmaster of the Atchison, Topeka & Santa Fe at Newton, Kan., and is succeeded by Arthur Jung, formerly roadmaster at Ellinwood, Kan. Joseph Westerhaus has been appointed roadmaster of the Little River districts at Ellinwood to succeed Mr. Jung. C. Kelley succeeds H. S. Cox as roadmaster at Guthrie, Okla. F. W. McNutt, roadmaster at Albuquerque, N. M., has been transferred to Gallup, N. M. B. F. Gauldin, roadmaster at Barstow, Cal., has been transferred to San Bernardino, Cal., and is succeeded by L. B. Parsons, formerly at Kingman, Ariz. A. Ray, roadmaster at San Bernardino, has been appointed roadmaster on the First district, succeeding W. F. Perris, the office being at San Bernardino. L. B. Parsons, transferred, has been succeeded by J. A. Rohrer, formerly at Needles, Cal. Mr. Rohrer's office is at Kingman, Ariz.

New Books

PRACTICAL CEMENT WORK. By W. B. Henry; 110 pages, cloth; 4x6½ inches. Published by The Concrete Age Publishing Co., Atlanta, Ga. Price $0.50.

Practical Cement work was written to give the contractor and laborer information valuable in both general and detail concrete work. Fundamentals only are considered. Theory, wherever gone into, is treated in language and in a manner which is easily understood. While the work was written primarily for the untechnical, there is much of practical interest to the engineer engaged in concrete construction.

The first chapter in the book gives the composition of Natural and Portland cements, the difference between them, and the great advantage of Portland over Natural cement. Further chapters discuss the requirements of sand and aggregate, proper proportions for different class construction, and principle of mixing and placing. Methods to be used in many different structures are given, with precautions necessary before, during and after placing concrete.

RAILWAY CONSTRUCTION.

Ransom & Cook, Ottawa, Kan., have been awarded the contract for the first 60 miles of the Atchison, Topeka & Santa Fe's new line from Dodge City, Kan., southwest.

The Arkansas & Memphis Railroad Bridge & Terminal Co., which filed its charter recently, is understood to be planning the construction of a new bridge over the Mississippi River and the building of new terminals at Memphis. The work is to be done for the Chicago, Rock Island & Pacific, and it is said the project will involve the expenditure of $10,000,000 to $15,000,000. J. T. Hanrahan, Chicago, Ill., former president of the Illinois Central, is at the head of the company.

Surveys have been completed by the Central Missouri, and it is believed work will be started on the construction in the near future. As proposed, the line will start at Reyno, Ark., and will extend via Maynard, Ark., through Southern Missouri to Jefferson City.

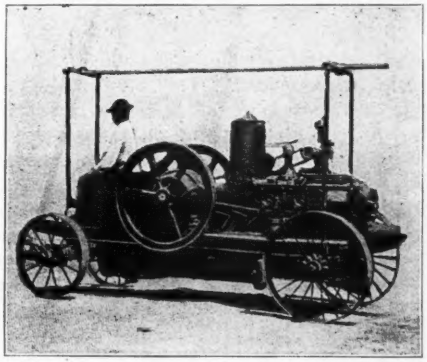
The Chicago, Burlington & Quincy is said to be planning the construction of a new roundhouse and turntable at Beardstown, Ill.

With The Manufacturers

CEMENT GUN IN CONSTRUCTION.

The methods of mixing and applying cement in many forms of construction work seem destined to be revolutionized by the introduction of the "Cement Gun" into general use. This "gun" is a device for applying cement by compressed air, the dry cement and sand being forced through a hose and mixed with water introduced at the nozzle, just before the cement leaves the hose. The wet mixture of cement mortar is directed by this nozzle to the surface or location on which the cement is applied.

This machine consists of two cylindrical chambers. A swinging gate valve operated by the handle shown extending from near the top of the upper cylinder admits the dry mixture of cement and sand. When the cylinder is charged sufficiently the air pressure of 30 pounds per square inch is admitted to this upper chamber by means of a valve in the vertical pipe. The lower chamber is fitted with a gate valve similar to the one in the opening of the upper chamber. The air pressure in the upper chamber keeps the upper valve

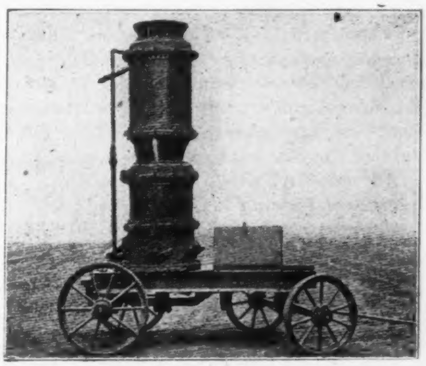


Compressor Outfit for Cement Gun.

closed, and as the pressure in the upper chamber becomes equal to that already existing in the lower, the weight of the charge opens the lower valve downward and the charge drops into the lower chamber. The gate valve at top of the lower chamber is then closed by means of the operating handle, and the air pressure valve to upper chamber closed. This permits the pressure in the lower chamber to hold its gate valve or top door closed, and the pressure forces the "mix" out into the hose, through which the air passes at a high velocity due to the pressure system. The "mix" is agitated or loosened up in the lower part of the lower chamber just before it passes into the hose by means of an air motor driven feed wheel, which revolves horizontally and thus delivers small charges of the loose mix directly into the air current of the hose. It is driven through this hose to the point where the cement is to be applied. As it reaches the nozzle a fine spray of water from a smaller hose is forced by the ordinary city or other pressure into the midst of the stream of cement as it pours out the nozzle. This is effected by means of a sleeve over the cement nozzle, into which the end of the water hose directs the water. This sleeve guides the circle of spray into the cement stream as the mixture passes out. The stream of cement is continuous, and the charging or loading of the cement gun goes on as fast as the work demands. The upper chamber is ready for a new charge as soon as each charge drops into the lower chamber.

The air compressor, it will be readily seen, must be a portable one, a self-contained outfit, reliable and uniform in action. The Chicago Pneumatic compressor, as shown in the illustration, a specially designed mounted gasoline driven outfit, is used as an adjunct to furnish the compressed air at about 30 pounds per square inch, to the hose system.

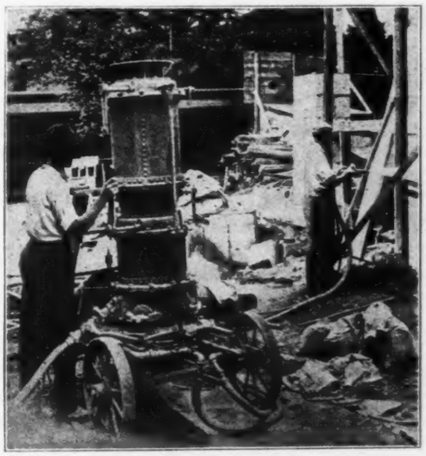
The cement mortar impinges on the surface treated, and as it strikes with considerable force it makes a dense coating, all surplus water and air being forced out, giving a substan-



Cement Gun.

tial construction, and when waterproof cement is used a waterproof building construction results. The uses to which the cement gun may be applied are many, and new applications are constantly being found for it.

It is now used on the Panama Canal construction for coating the rock surface in Culebra Cut to prevent disintegration and resulting slides. It is also in use on Government work in Hawaii and the Philippines. In constructing the ordnance shop and dwellings at the United States Army Post in Hawaii a mixture of one part cement to two and one-half parts sand was applied. Triangular wire mesh was secured by staples to the studding of the structure, and this was backed up by heavy building paper so the wire mesh came in



Cement Gun in Action.

center of one and one-quarter inch thickness of cement when sprayed on. In the dwellings the cement was sprayed on three-quarter in. thick inside of studding. The framing of the buildings supply the structural strength, the cement being required to maintain its own weight only.

The cement gun is applicable to foundation work and waterproofing below grade, coating steel to prevent corrosion, and for retarding heat in case of fire; for coating inside and outside of large steel water pipes, coating and water-

proofing railroad tunnels, highway bridges, etc., constructing water and sewer pipe flumes, for building walls, cement stucco and plaster work, covering old wooden buildings, walls and roofs, waterproofing cellars and building fences and sidewalks. Complete fireproof buildings can be constructed by using special designs of framework. Colors can also be applied as required. The "gun" is equally successful in applying hydrated lime, Gypsum, "Alca" lime and similar plastic materials. In railway work the cement gun can be used to great advantage in placing concrete for tunnel linings.

Occasions are cited in a recent issue of the *Engineering Record* where repairs were successfully made to a heavy concrete sea wall near Boston, which was built to break the impact of the waves and prevent erosion of the shore lands. The constant wetting of the wall by the spray and the varying exposure of the low portions of the wall due to the rise and fall of the tides, tended to damage by disintegration of the concrete face, forming large holes and scaled patches exposing the large stones of the concrete aggreate. Attempts to patch by hand, using a Portland Cement mortar were not entirely satisfactory for several reasons. The "Cement Gun" was then used with most excellent results. The cement gun is manufactured for the General Cement Product Co., 30 Church St., New York, by the Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, and the latter company is supplying it to the railway trade.

TRACTION ENGINES FOR GRADING.

In building grade on the Grand Trunk Pacific between Regina and Moose Jaw, Rigby, Hyland & Plumber used two 45 brake horsepower (22 tractive) traction engines for pulling grading machines. These machines loosen up the dirt and carry it in an endless apron carrier onto the grade or into dump wagons.

The Hart-Parr tractors, which were used, can be successfully operated on kerosene, distilate or gasoline.

The engine is of the "hit and miss" type, taking a full charge of gas, or none, and taking as many charges as the load makes necessary. The governor is of the centrifugal type commonly used on high speed steam engines, and it rotates two and one-half times as fast as the crank shaft, thus making it very sensitive and at the same time powerful. This, in connection with the double cylinder construction, gives a very steady motion. The governor has but few parts, is not affected by the movements or change of incline of the engine, does not easily gum up and become inoperative, and is very durable.

The experience gained in the extended use of automobiles has shown that the "float" feeding apparatus is simple and reliable, and this type of gasoline feeder is used. The feeder has no needle valves or small passages to choke (the smallest passage being one-fourth inch in diameter), and provision is made for separating paraffine, sediment or water from the fuel. The vibration of the engine, jolting over the roughest roads, or placing the engine on any incline up hill or down, has no effect whatever on its ability to supply the proper amount of fuel to the cylinders at all times.

Every gear or pinion used in this tractor is either a steel casting or semi-steel. The gears are of unusual size and are strengthened at the points receiving the greatest strain. They are attached rigidly to the truck frame in such a manner that they cannot get out of proper mesh or alignment. As there is no shifting of gears at any time they will always maintain their relative position towards each other. For the forward movement no gear is used as an intermediate or idler gear, but all are keyed rigidly to the shafts. The power is transmitted from the crank shaft to the drive wheels through only two pairs of gears and pinions, this being the most simple and positive drive known. The differential gear is keyed on the rear axle, which revolves, and thus the gears always preserve their relative positions, insuring greater strength and life.

The power is transmitted from the crank shaft to the gears by improved friction clutches of exclusive design, provided with large friction blocks engaging on metal surfaces of large diameter, thus insuring a positive grip and yet manipulated with but very little muscular exertion, and capable of starting the traction train of gearing gently, slowly or rapidly, forward or backward, without violence to any of the gearing. Two clutches are used, one for the forward and one for the backward movement, and both are operated by a

Grading Machine Placing Filling Directly in Embankment. Drawn by a Hart Parr Tractor.

single lever, so arranged that when moved to the center neither clutch is engaged.

No brake is required, as the reversing clutch, if applied gradually, acts as a brake to stop the traction drive or hold it when descending a steep incline. The operating lever is placed in convenient reach of the operator, and by its use alone the engine is easily handled, and under complete control. The reversing mechanism is of the "planetary" type, similar to that used in many automobile transmissions. These tractors are supplied with a "Z" bar coupling, and also with a swinging draw-bar which pulls from a point just back of the rear axle.

Advantages claimed for this tractor: There is no danger from freezing in cold weather, no trouble about impure water or scant supply, and no expense of men and teams to draw water and coal; there are no boiler feeders to choke or gauges to watch, nor boiler to scale; there is no danger, as an explosion is an impossibility, and when stopped there is no steam pressure to rise rapidly and cause trouble; as no coal is used for fuel the fireman is dispensed with, and there is no possible danger from fires from the engine, even if it is set in a barn; the convenience in moving on account of hav-

Grading Machine Loading Dump Wagons, Hart Parr Tractor.

ing no coal or water supply to provide can hardly be overestimated; there are no flues to keep clean and frequently replace, and no grate bars to burn out; an expensive licensed engineer is not a necessity, as the tractor can be operated successfully by any man of good mechanical ability, and only one man is needed; it is ready to start at any time—no firing from one to three hours before starting time is required; it can not waste any time taking on water and coal while hauling; it can be used in many places where steam tractors cannot go on account of excessive weight.

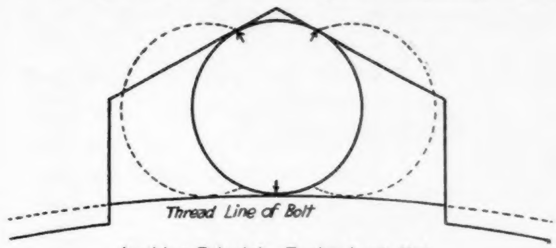
No tractors can be successfully used on swampy, marshy ground, and on hilly ground their effective power rapidly

decreases, so that on grades of 12 to 15 per cent they cannot pull more than half as much as they can on the level.

In the grading on the Grand Trunk Pacific about 225 cu. yds. of material was handled per day on level prairie at an operating expense of about $17.00 per tractor. The cost of fuel in that country is excessive, however, and in some instances costs two or three times as much as in the United States. The tractors described above are manufactured and sold by the Hart-Parr Co., Charles City, Ia.

TAYLOR LOCK NUTS FOR TRACK BOLTS.

Taylor lock nuts have been installed on sections of the Oregon Short Line, and the San Pedro, Los Angeles & Salt Lake R. R. A division engineer on the latter road has given us the following information in connection with the above: "We have had some Taylor lock nuts in our main track since June 27, 1911, and an examination on Oct. 10 showed them all to be tight, and none have required readjusting or any care since first applied. While this short test is not conclusive, it indicates that this may prove a valuable device."



Locking Principle, Taylor Lock Nut.

An assistant superintendent of the Oregon Short Line writes: "We have had some Taylor lock nuts on track bolts on our main line through Salt Lake yard for about six months. In going over these we find them all in good shape and no loosening of any bolt. On pulling the key and unscrewing nut we find that the threads are still in good condition and when we replaced the nut on bolts that were removed and put the key back, they were tightened up in the same condition as when it was first put on."

"We are very much pleased with the action of these nut locks and service so far as we have been able to ascertain up to the present time."

New Literature

NEW LITERATURE.

The National Surface Guard Co., The Rookery, Chicago, has made a reissue of its catalogue of surface guards, showing a number of new designs, in addition to those shown in former issues. All of the types shown may be made of either open hearth steel or rust-resisting metals, as specified. Surface guards are also made of either wood or metal to any special design or specification. The standard designs, which are well illustrated and described, are well made, quickly installed, do not rattle, and are easily removed for repairs. No extra length ties or special preparation is necessary in installation. The use of metal stock guards has been given an impetus by railways adopting means for preventing brine from dripping from refrigerator cars in transit.

* * *

The J. M. Dodge Co., Nicetown, Philadelphia, Pa., has issued a booklet describing the mechanical handling of package freight at railway terminals and steamship piers. This catalogue contains a rather complete treatise on the subject by M. B. Waterman. The conditions that have to be met are considered in some detail, and then a number of plans are evolved to meet typical conditions. Descriptions and diagrams are given designed to fit conditions in an Inbound and Outbound Terminal, an Outbound Station, a Transfer Station, and a Steamship Terminal. In the last part of the book the use of Telphers for freight handling is described, with illustrations from actual service.

* * *

Catalogue No. 11, issued by the Hart-Parr Co., Charles City, Ia., contains complete illustrations and descriptions of this company's line of traction engines. These tractors will operate on gasoline, kerosene or distillate. The frontispiece is a picture of the large plant at Charles City. The general features of Hart-Parr construction are treated in the first pages, with illustrations of patent or exclusive designs. Following the general notes are a number of pages given over to a detailed description, with illustrations, of a number of tractors of different designs and varying power.

Industrial Notes

A. W. Heinle, engineer in charge of rail manufacture, rail joint construction and rolled track equipment, has resigned from the Heinle Co., of Pittsburgh, Pa.

G. H. Macdonough, superintendent of construction for the General Railway Signal Co., Rochester, N. Y., with office at Chicago, has been made general manager of the Potter-Winslow Co., Chicago.

F. H. Jones, assistant resident manager of the Chicago office of the General Railway Signal Co., Rochester, N. Y., has been made resident manager at San Francisco, Cal. C. O. Poor, general superintendent of the Rochester works of the company, succeeds Mr. Jones.

F. C. Lavarack, signal engineer at New York for the Federal Signal Co., Albany, N. Y., has resigned to become general sales manager of the Signal Accessories Co., with offices recently established at 140 Nassau street, New York. The Signal Accessories Co. will manufacture signal materials, and in addition, handle the sales of the United Electric Apparatus Co., Boston, Mass.; the W. F. Bossert Manufacturing Co., Utica, N. Y.; the American Conduit Co., East Chicago, Ind., and others.

The Chesapeake & Ohio Railway, which has had more than 200 Gill selectors in service in telephone train dispatching has now ordered from the United States Electric Co. 52 additional selectors. The Central Vermont Railway, has recently received 31 additional selective station outfits from the above company.

Mr. Francis W. Frost, formerly secretary and treasurer of the Engineering News Publishing Co., has been elected to the office of vice-president and treasurer of Suffern & Co., 96 Wall street, New York city.

A railway supply salesman with ten (10) years' experience would like to represent manufacturers in Chicago and the West. References. Address W. C., care Railway List Co., 431 So. Dearborn St., Chicago.

George W. Daves, formerly signal engineer of the Chicago & Alton, is now in the sales department of the Edison Storage Battery Company, Orange, N. J.

The Railway & Mill Equipment Co. has been established at New Orleans, La., to sell railway supplies. Seely Dunn and J. Otho Elmer are officers.

Dwight P. Robinson and John W. Hallowell have been made members of the firm of Stone & Webster, Boston, Mass.

The Utah Construction Co., Ogden, Utah, has started work on its contract for building an extension of the Oregon Short Line from Vale west, up Malheur Canyon to Dog Mountain, which is a point near Harney Lake. The work includes much heavy grading, several tunnels and some big bridges, and will cost approximately $6,000,000 for the 139 miles.

Recent Engineering and Maintenance of Way Patents

PATENTS.

SIGNAL FOR RAILWAY SWITCHES.

1,001,801—A. H. Johnson, Epsom, England.

The combination with a railway switch having a fixed rail and a removable rail, of a signal, a follower rod, means causing the follower rod to bear freely against the movable rail throughout its movement, and means co-operating with the follower rod for preventing the signal from being given when the movable rail is not completely set.

FOOT GUARD.

1,011,654—J. W. Stephenson, assignor to The National Malleable Castings Co., Cleveland, O.

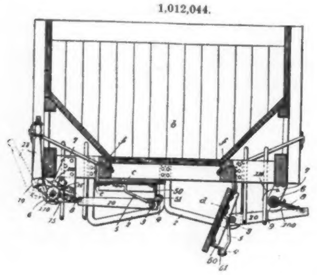
A foot guard for railway track structures comprising an upper plate member adapted to fit underneath the heads of adjacent rails, rear supporting member upon which the upper member has an inclined sliding bearing, and a supporting spring underneath the opposite end portion of the upper member.

RAILWAY SIGNALING SYSTEM.

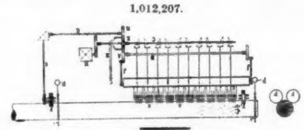
1,011,291—H. A. Wallace, assignor to the Union Switch & Signal Co., Swissvale, Pa.

This railway signaling system has three successive block sections, a home signal for the third block section and a distant signal for the home signal, a track circuit for each of the block sections, each including a source of current and a relay as a pole charger; included in the second track circuit is a pole changer operated by the relay for the first track circuit; also a polarized armature included in the relay for the second track circuit and responsive to changes of poplarity of the second track circuit, a signal relay for the home signal, a circuit including the signal relay, a source of current, a contact of the polarized armature and an armature contact of the relay for the third track circuit, a controlling circuit for the home signal which circuit is governed by the signal relay, a signal relay for the distant signal and comprising a polarized armature, a circuit for the distant signal relay including a source of current, a neutral armature contact of the relay for the second track circuit, and a pole-changer operated by the home signal, and a controlling circuit for the distant signal, which circuit includes a contact of the polarized armature of the distant signal relay.

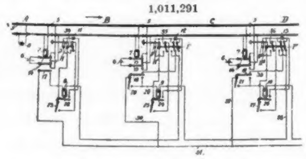
1,012,044.



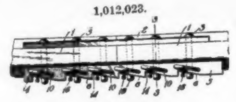
1,012,207.



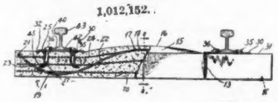
1,011,291

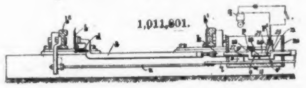


1,012,023.

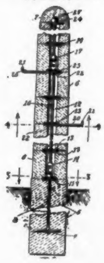


1,012,152.





1,012,423.



RAIL FASTENING DEVICE.

1,011,245—J. M. Rafter, New York, N. Y.

This device consists of insulated wear plates in combination with and mounted on a tie, a rail seated upon the upper wear plate, oppositely disposed coacting wedge shaped gripping devices mounted upon the wear plate and engaging opposite sides of the base flange of the rail, and an insulated bolt for securing the gripping devices in operative position.

RAIL JOINT.

1,012,023—Harry Souden and W. S. Leahy, Lebanon, Pa.

The combination with adjacent rail ends and a fish plate at one side of the rails, of a wedge plate formed with horizontal longitudinally extending slots and wedge portions, bolts extending through the fish plate, rail, and slots in the wedge plate, and formed with shoulders to engage the wedge portions; and wedges engaging the wedge plate at one edge and the bolts at their opposite edge to move the plate longitudinally and prevent the lateral movement of each of the bolts.

DUMP CAR.

1,012,044—W. H. Yost, assignor to National Dump Car Co., Chicago.

A dump car presenting a single longitudinal discharge opening, a pair of doors hinged at the side edges of such opening, rails located at the ends of said opening, a pair of laterally movable shafts supported on the rails, bearing members fixed upon the doors and each presenting an angular tread surface, a part whereof is inclined away from the door surface at a slight angle and another part at a sharper angle inwardly toward such door surface, the first mentioned part and the corresponding part of the coacting supporting rail converging slightly outwardly when the door is closed; means are provided for moving the shafts laterally.

ANTI-FRICTION RAIL.

1,012,093—David Mauck, Greenville, Mo.

This rail has an aperture in the side thereof, elongated rollers adapted to be received in the aperture in such a manner that a segment of the rollers will project beyond the side of the rail, whereby the flange on the wheel which travels on the rail will engage the rollers, and whereby they will rotate in the direction of the rotation of the wheel thereby preventing the same from climbing the rail.

CONCRETE TIE AND RAIL SECURING MEANS.

1,012,152—E. R. Pollard, Los Angeles, Cal.

A concrete tie having spike sockets embedded therein, adapted to bind upon the edges of spikes, the sockets being adapted to curve the body of the spikes.

PROCESS OF IMPREGNATING TIMBER.

1,012,207—Samuel Haltenberger, Budapest, Austria-Hungary.

An economical process for impregnating timber, such as poles for aerial lines, consisting in piercing radial pricks in the wood by merely displacing the fibers thereof without severing them and without removal of material, and impregnating this pricked timber with a preserving fluid, by pressure.

RAILWAY SIGNAL TORPEDO.

1,012,342—Frank Dutcher, Versailles, Pa.

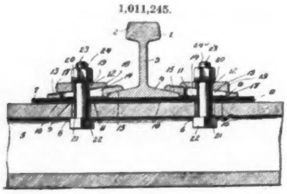
This railway torpedo comprises an inclosing case, consisting of ductile material, the inclosing case having outwardly projecting rail-engaging members; an explosive within the case and a strengthening strip passing through the case between the explosive and the rail-engaging side of the case, the strip also extending through the extensions.

SECTIONAL CONCRETE TELEGRAPH POLE.

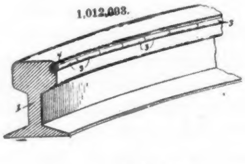
1,012,423—W. J. W. Orr, Anaheim, Cal.

This patent relates to a composite pole comprising a series of hollow sections, applied end to end, a sectional tie bolt passing longitudinally through all of said sections, turn-buckles connecting the adjacent ends of the tie bolt, the interior diameter of the section being ample to slip over the turn-buckle, washers threaded upon the tie bolt and counter sunk in the adjacent ends of the pole sections for preventing their slipping, and step pieces mounted between some of the sections of the pole.

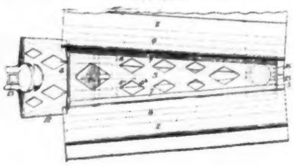
1,011,245.



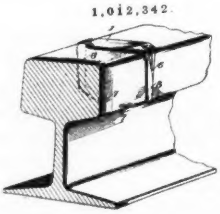
1,012,603.



1,011,654.



1,012,342.



The Baltimore & Ohio has ordered 500 tons of bridge steel from the McClintic-Marshall Co. for use in Chicago.

The Buffalo, Rochester & Pittsburgh has ordered 1,300 tons of bridge material from the American Bridge Co.

The Great Northern has placed an order for 38,000 tons of steel rails, divided between the U. S. Steel Corporation, the Lackawanna and the Cambria Steel Companies.

The Minnesota, Dakota & Western has ordered 2,000 tons of rails from the Illinois Steel Co.

The South African Rys. are receiving bids for 4,708 tons of steel rails, 714 tons of chair-plates and 300 tons of fish-plates.

The Southern has ordered 21,000 tons of rails from the Tennessee Coal, Iron & Railroad Co.

The Stone & Webster Engineering Corporation at Keokuk, Ia., is in the market for fifteen miles of 25, 30 and 35-pound rails and steel ties for either 24 or 30-in. gage.

The Transcontinental will receive tenders until January 10 for 14,468 tons of 80-lb. rails, and the necessary rail fastenings.

The Western Maryland is getting prices on 3,000 tons of rails for immediate delivery.

New Dixon Railroad Booklet

We have just prepared a booklet treating of the various Dixon graphite products for use on the railroad. The entire Dixon railroad line is treated of and all other matters excluded—this booklet is of interest only to the various mechanical railroad departments.

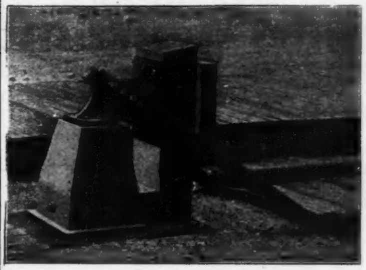
The application of dry graphite for lubrication, the use of Dixon's graphite greases, Dixon's Silica-Graphite Paint, crucibles, facings, crayons, etc., is all included in this booklet—a total of 40 pages. There is bound to be some matter to interest you here.

We have tried to make our booklet attractive in appearance as well as interesting to read, and to this end have included views taken of railroad stations and yards, stretches of track, signals, bridges, etc.

Write for copy of this booklet by number 187 R. R.

Joseph Dixon Crucible Co.

Jersey City, N. J.



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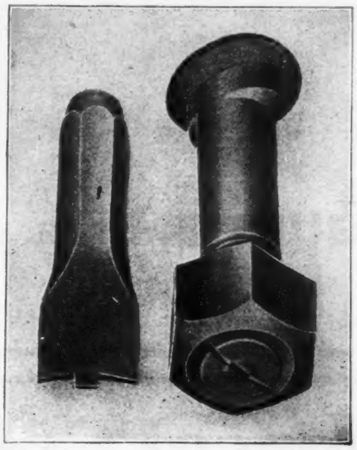
Noted for Simplicity, Strength and Lasting Qualities. Adapted to all positions.

Mechanical Mfg. Co.,

CHICAGO. ILL.

THE CLARK NUT LOCK



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ADJUSTABLE

The Interlocking Nut & Bolt Co.
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The advertising pages of a paper add to its value to the subscriber, bring before him the newest developments of progressive manufacturers, and aid in his information as to the best methods and implements to be used in the accomplishment of his problems.

The trade paper that is edited for the man who pays his dollar is the paper that will get the business, and nothing can stop it. When the publisher prints a paper that the subscribers want to read and do read, and which represents them and their point of view, he is presenting something to the advertiser that is so valuable that its value cannot be computed by the rates on the back of the contract blank. The beginning of service in a trade paper that expects success must come in its reading pages.

TIE PLATES From New Steel Billets. Send for Catalogue E. **THE RAILROAD SUPPLY CO** Bedford Building, Chicago

WATER SUPPLY, RAILROAD TANKS, IRRIGATION or COUNTRY HOMES

Pumps Water with Water Power. No Attention. No Expense. Runs Continually.

RIFE AUTOMATIC HYDRAULIC RAM

Complete System extending to stable, greenhouse, lawn, fountains and formal gardens.

Operates under 18-in. to 50-ft. fall. Elevates water 30-ft. for every foot fall used. 80 per cent efficiency developed. Over 8,000 plants in successful operation. Large plants for towns, institutions, railroad tanks and irrigation. Catalogue and estimates free.

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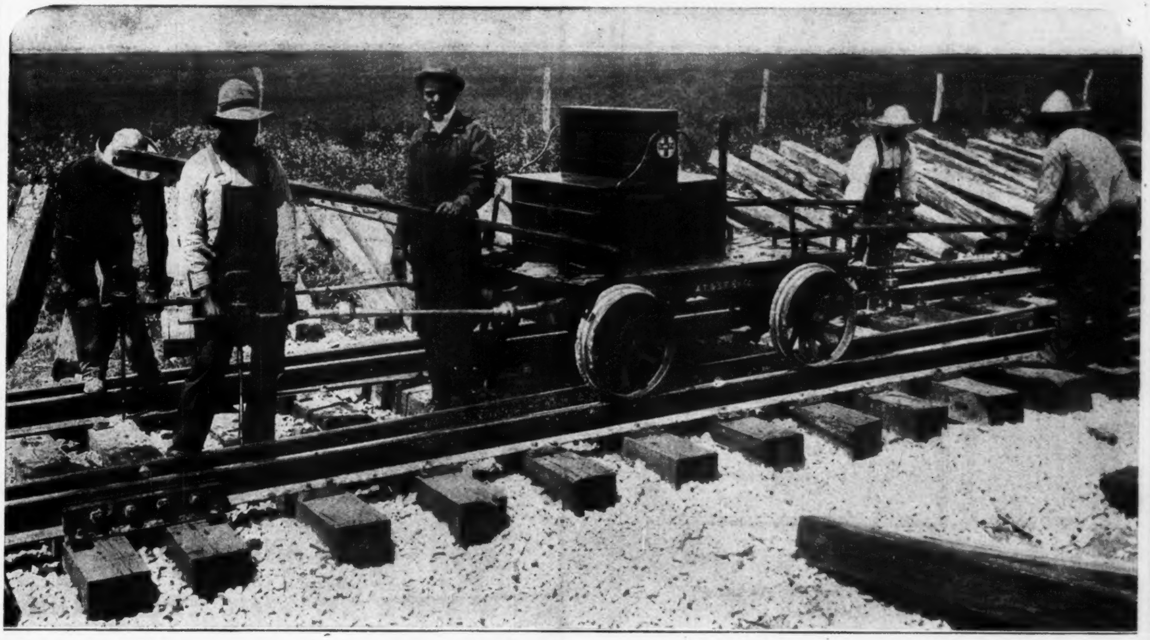
SCREW SPIKES

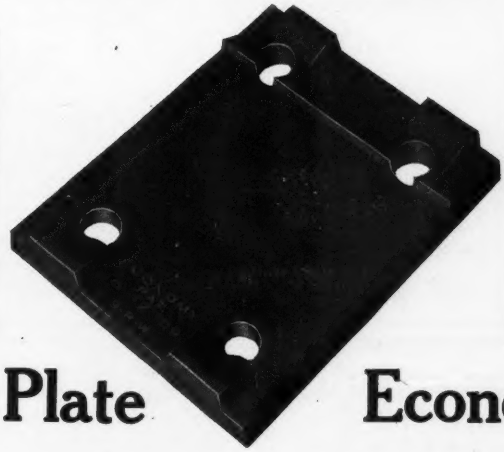


AU-TRA-KAR

The Machine that Bores the Holes and Drives the Spikes

The Au-Tra-Kar

¶ A Gasoline propelled motor car and the only one that will do the work. The illustration above shows actual working conditions.



Economy No. 9RW

Screw Spike Tie Plate

¶ Rolled from open hearth steel. The plate that makes possible the proper application of the Screw Spike.

The Tie Plate Economy 9RW

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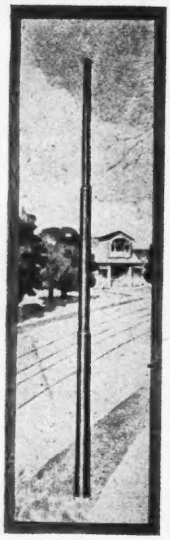

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Let us estimate on your requirements

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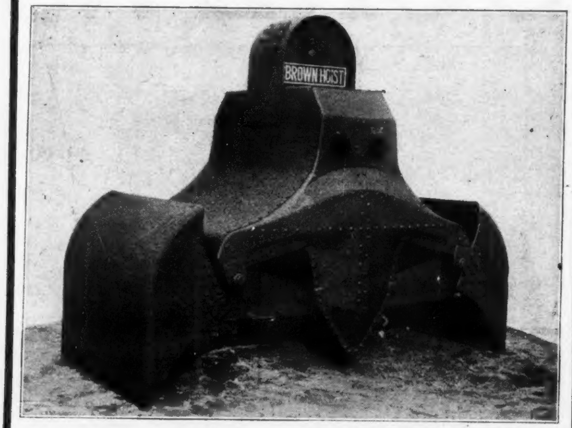
"BROWNHOIST"



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By a demonstration of over twenty months under both Passenger and heavy Freight traffic

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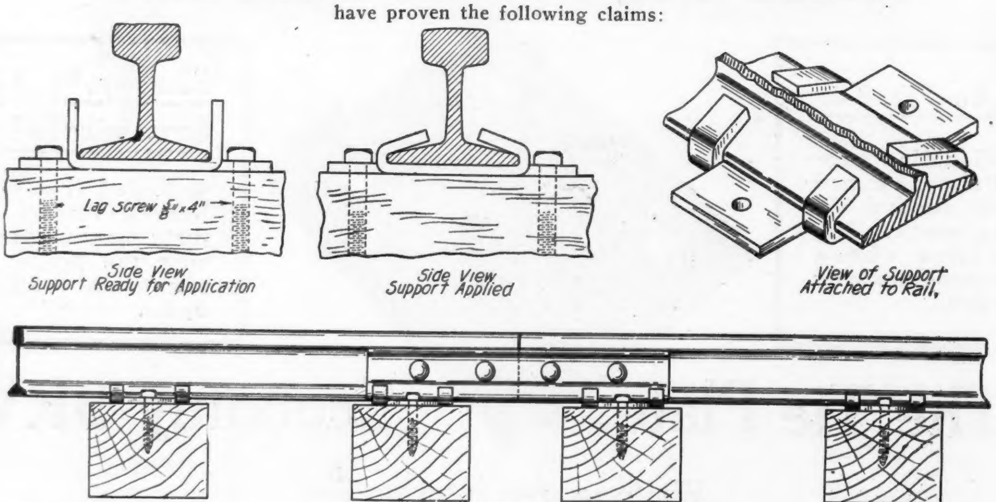

Side View
Support Ready for Application

Side View
Support Applied

View of Support
Attached to Rail,

End View of Support Attached to Rail

No creeping, spreading or kinks. Supports do not loosen on tie or rail.
No deflection or mechanical injury to the tie.
No expense in maintenance since supports were applied.
Eliminates the purchasing of tie plates, because it is the best tie plate on the market, without its other merits.
Also eliminates rail braces, continuous joints, and anti-creepers.
It holds the rail absolutely in alignment either on Tangents or Curves.
It keeps your track to the exact gauge without the use of braces or other devices.
Preserves ties.
Permits the use of the less expensive class of timber.
It acts as an Anti-Creeper because it prevents wave motion of the track under traffic.
It avoids all possibilities of derailments due to rail breakage.
It does all these things, and at the same time costs no more than many tie plates now on the market, and is just as easy to apply.

VAUGHN RAIL SUPPORT COMPANY, **Pierce Bldg., ST. LOUIS, MO.**